Behavioral and Brain Sciences

cambridge.org/bbs

Why imaginary worlds? The psychological foundations and cultural evolution of fictions with imaginary worlds

Edgar Dubourg and Nicolas Baumard

Département d'études Cognitives, Institut Jean Nicod, ENS, EHESS, PSL University, CNRS, Paris, France.
edgar.dubourg@gmail.com

Target Article

Cite this article: Dubourg E, Baumard N. (2022) Why imaginary worlds? The psychological foundations and cultural evolution of fictions with imaginary worlds. *Behavioral and Brain Sciences* **45**, e276: 1–72. doi:10.1017/S0140525X21000923

Target Article Accepted: 30 June 2021
Target Article Manuscript Online: 8 July 2021
Commentaries Accepted: 4 October 2021

Keywords:
Cognitive attraction; cultural evolution; curiosity; exploration; fiction; imaginary worlds; novelty; reward

Abstract

Imaginary worlds are extremely successful. The most popular fictions produced in the last few decades contain such a fictional world. They can be found in all fictional media, from novels (e.g., *Lord of The Rings* and *Harry Potter*) to films (e.g., *Star Wars* and *Avatar*), video games (e.g., *The Legend of Zelda* and *Final Fantasy*), graphic novels (e.g., *One Piece* and *Naruto*), and TV series (e.g., *Star Trek* and *Game of Thrones*), and they date as far back as ancient literature (e.g., the Cyclops Islands in *The Odyssey*, 850 BCE). Why such a success? Why so much attention devoted to non-existent worlds? In this paper, we propose that imaginary worlds co-opt our preferences for exploration, which have evolved in humans and nonhuman animals alike, to propel individuals toward new environments and new sources of reward. Humans would find imaginary worlds very attractive for the very same reasons, and under the same circumstances, as they are lured by unfamiliar environments in real life. After reviewing research on exploratory preferences in behavioral ecology, environmental esthetics, neuroscience, and evolutionary and developmental psychology, we focus on the sources of their variability across time and space, which we argue can account for the variability of the cultural preference for imaginary worlds. This hypothesis can, therefore, explain the way imaginary worlds evolved culturally, their shape and content, their recent striking success, and their distribution across time and populations.

1. Introduction

The world around fictions with imaginary worlds draw acclaim from the public, the critics, and the industry, making them both best-selling and most-appreciated fictions (e.g., top-ranked in online ranking websites). For instance, *The Lord of the Rings* novels are among the best-selling novels ever written, with more than 150 million copies sold in 38 different languages. The screen adaptations by Peter Jackson grossed each around 1 billion dollars in box-office worldwide, making them among the highest-grossing films ever produced. They received universal critical acclaim and won 17 Academy Awards. *The Return of the King* alone won 11 of them, setting the current record of the most Oscars won by a single movie. This sequel is the fifth film in the "all-time top-rated movies" list from IMDb, the biggest user-generated ranking dataset on films. Producers of fictions know just how lucrative this kind of fiction can be: After a competitive bid against HBO and Netflix, Amazon bought the rights to produce TV programs based on Tolkien's imaginary world for 250 million dollars, which is by far the most expensive script idea ever sold. Tolkien's world has also been adapted into theatre, radio, board games, video games, and role-playing games (e.g., *Dungeon and Dragons* and *Middle-Earth Role Playing*).

Several other fictions can be mentioned: *Star Wars*, the most successful fiction merchandising franchise of all time (Block & Wilson, 2010) and arguably the most influential movie in the history of films (Canet, 2016); *Harry Potter*, the best-selling book series in history, translated into 80 languages; *Game of Thrones*, whose final episode set the all-time audience record for a TV series with 16.4 million people watching it live and 15 million people streaming it later; *The Legend of Zelda*, one of the best-selling video game series worldwide, with over 100 million video games sold since the first one; and the Marvel Cinematic Universe, a shared imaginary world including a series of super hero films with common settings and characters, which cumulates several records in the history of cinema, including the highest opening week gross (*Avengers: Endgame*), the biggest opening week-end (*Avengers: Infinity War*) and, more significatively, the highest-grossing movie of all time (*Avengers: Endgame*). A more quantitative approach confirms that fictions with imaginary worlds are highly successful in recent times: the numbers of novels with imaginary worlds and the number of films with imaginary worlds have considerably increased in the last 100 years, both in absolute terms and relatively to the

CAMBRIDGE UNIVERSITY PRESS

global levels of production of novels and films (Dubourg, Thouzeau, de Dampierre, & Baumard, 2021).

The examples of *The Lord of the Rings*, *Star Wars*, and *Harry Potter* are startling, because they are without any doubt the most popular fictions worldwide and, at the same time, the fictions which may have pushed the building of imaginary worlds the furthest, notably if we consider the amount of background information generated by their creators. Tellingly, in cultural studies, it has been argued that "more and more, storytelling has become the art of worldbuilding, as artists create compelling environments that cannot be fully explored or exhausted within a single work or even a single medium" (Jenkins, 2006, p. 117; see also Besson, 2015; Saler, 2012; Wolf, 2012, 2017a, 2021). This goes to the point that imaginary worlds without any narrative have become to appear. One compelling example is the *Codex Seraphinianus*, an encyclopedia of an imaginary world with no story or protagonist (Serafini, 1981). Imaginary worlds are also invading mainstream literature with novels such as *The Possibility of an Island* by Michel Houellebecq which blurs the lines among science-fiction, alternative history, and highbrow general fiction.

This cultural phenomenon is not at all limited to the United States and the English-speaking Western countries. *Harry Potter*, *Star Wars*, and *The Lord of the Rings* are highly popular all around the world, and in fact, these franchises make most of their revenues outside North America (Kuipers & de Kloet, 2009). Also, several imaginary worlds consumed all around the world are produced outside the English-speaking world, from the Japanese manga *One Piece*, which has become the best-selling manga series in history with its 470 million copies sold in 43 different countries, to Liu Cixin's best-seller *The Three-Body Problem*, the first Asian novel to win the American Hugo Award (Chau, 2018). In this sense, a psychological and evolutionary understanding of the appeal for imaginary worlds is long overdue.

2. Imaginary worlds and world-dominant fictions

Fictions differ in the degree to which they distinguish themselves from the real world. For instance, in Balzac's novels, the fictional environment depicted is identical to France from the author's period and, while Balzac added approximately 3,000 fictional individuals, we intuitively picture the protagonists within the real world (Pavel, 2017). We infer much information derived from our folk knowledge of the real world, such as the country in which the fiction takes place, its geography, its political institutions, and the technology available. In fiction study, this idea is captured by the notion of "principle of minimal departure" (Ryan, 1991; Searle, 1975) or "reality principle" (Pavel, 2017; Walton, 1993). Conversely, Tolkien's "subcreated" world, Arda, is ostentatiously different from any environment in the real world (Tolkien & Tolkien, 2006), and so is *One Piece* world, with its imaginary planet and its only continent called the Red Line. Both imaginary worlds are not only populated by humans, but also by several other imaginary races, and both include several elements that do not exist in the real world.

Following these examples, the key determinant of our definition of an imaginary world is the background knowledge required to understand the fiction, because it differs from the knowledge of the real world. Imaginary worlds are fictional environments that the recipients of the fiction could not have possibly explored in real life, be it far removed islands, locations in the future or the distant past, other planets, or environments in alternative history. In fact, in the example of Tolkien, the background information is commonly considered by literary critics as the most important feature (Jourde, 1991). In 1956, Tolkien wrote a letter which displays the crucial interest of his readers for background information:

> Most people want more (and better) maps; some wish more for geological indications than place-names; many want more specimens of Elvish, with structural and grammatical sketches; others ask for metrics and prosodies, not only of the Elvish, but of the "translations" that are in unfamiliar modes – such as those composed in the strictest forms of Anglo-Saxon verse (e.g., the fragment on the Battle of Pelennor, Book Five, vi, 124). Musicians want tunes and musical notations. Archaeologists enquire about ceramics, metallurgy, tools and architecture. Botanists desire more accurate descriptions of the mallorn, of elanor, niphredil, alfirin and mallos, and of symbelmynë. (…) Historians require more details about the social and political structure of Gondor, and the contemporary monetary system (Letter to H. Cotton Minchin, April 16, 1956).

To sum up, by definition, a fiction based on an imaginary world is a fiction in which the consumer will learn a lot of novel information about the fictional environment (also called the "chronotope" in literary theory and philosophy of language; Bakhtin and Emerson, 1984). For example, *Harry Potter* has Hogwarts and several other magical locations, Jules Verne's *From the Earth to the Moon* has the Moon (which had obviously not yet been explored at the time of the author), the *Odyssey* has the Cyclops Islands, Aiaia, the Fortunate Islands, the Siren Island, and the Lotophages, to name only a few invented islands, and *The Lord of the Rings* is set in a complex alternate world with hundreds of invented locations. It is worth noting that religious narratives also involve unknown worlds that are, in a way, imaginary, with different physical laws and spatial structures, for instance. However, religious narratives cannot be considered as fictions. In this paper, we will limit our study to fictional worlds, mostly because non-fictional worlds such as religious worlds are likely to be culturally stabilized for reasons (e.g., authority) that differ from pure entertainment (Boyer, 2001).

Note that fictions with imaginary worlds are not the only fictions in which the background information is central. One could also mention historical novels such as Umberto Eco's *The Name of the Rose* and social realistic novels such as Zola's *Germinal*, where the environments, be it a medieval Benedictine monastery or as industrial mine complex, play a central role in the fiction,

Edgar Dubourg is a Ph.D. student at the Ecole Normale Supérieure – PSL University in Paris. He takes an interdisciplinary evolutionary approach to the psychological foundations of fictions. He is interested in the ecological, cognitive, and behavioral drivers of the cultural evolution of fictions, focusing on how cognitive adaptations, and more particularly adaptive plasticity, impact the variability of cultural preferences.

Nicolas Baumard is Directeur de Recherche at the CNRS and Professeur at the Ecole Normale Supérieure – PSL University in Paris. His research aims at understanding how cognitive and behavioral adaptations selected over the course of human history (e.g., moral sense, exploratory preferences, romantic love, etc.) can inform the structure and dynamics of social and cultural phenomena: social norms, religious beliefs, political institutions, fictions, and arts.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Table 1. Fictional genres of the broad category of speculative fictions, conducive to the building of imaginary worlds, with the definitions from Wikipedia and some modern examples

Genre	Definition	Examples
Fantasy	Includes elements and beings originating from or inspired by traditional stories, such as mythical creatures (dragons, elves, dwarves, and fairies, e.g.), magic, witchcraft, potions, etc.	*The Lord of the Rings, Dungeons and Dragons, The Legend of Zelda, Harry Potter, A Song of Ice and Fire, Magic: The Gathering, Kafka on the Shore, World of Warcraft*
Science fiction	Features technologies and other elements that do not exist in real life but may be supposed to be created or discovered in the future through scientific advancement, such as advanced robots, interstellar travel, aliens, time travel, mutants, and cyborgs	*The Time Machine, I, Robot, Dune, Star Trek, 2001: A Space Odyssey, Swamp Thing, Black Mirror, Star Wars, Blade Runner, Jurassic Park, The Hitchhiker's guide to the galaxy*
Adventure fictions	Features a fast-paced, action-packed plot in which the hero has to complete a quest or a task. The adventure story usually takes place elsewhere, and uses maps, intriguing backgrounds to interest the reader	*The Odyssey, Gulliver's Travels, Robinson Crusoe, The Jungle Book, Treasure Island, Two Years' Vacation, Michel Strogoff, Lord of the Flies, Up, The Revenant*
Uchronia	Focuses on historical events as if they happened in a different way, and their implications in the present	*The Man in the High Castle, The Last Starship from Earth, Once Upon a Time… in Hollywood*
Utopian	Takes place in a highly desirable society, often presented as advanced, happy, intelligent, or even perfect or problem-free	*Utopia, Island, Ecotopia, 17776, A Modern Utopia, Men Like Gods, Eutopia*
Dystopian	Takes place in a highly undesirable society, often plagued with strict control, violence, chaos, brainwashing, or other negative elements	*Brave New World, 1984, The Handmaid's Tale, A Clockwork Orange, The Hunger Games*
Superhero	Centers on superheroes (i.e., heroes with extraordinary abilities or powers) and their fight against evil forces such as supervillains	DC Universe, Marvel Cinematic Universe, *Naruto, Kamen Rider, X-Men, Super Sentai, Power Rangers*
Supernatural	Exploits as plot devices or themes some contradictions of the commonplace natural world and materialist assumptions about it	*The Castle of Otranto, Stranger Things, Paranormal Activity, Dark, Fallen, The Vampire Diaries, Charmed*
Apocalyptic	Takes place before and during a massive, worldwide catastrophe	*On the Beach, Threads, The Day After Tomorrow, 2012, World War Z*
Post-apocalyptic	Focuses on groups of survivors after massive worldwide disasters	*The Stand, Mad Max, Waterworld, Fallout, Metroid Prime, Metro 2033, The Walking Dead*

although it resembles the real world. Thus, fictions with imaginary worlds belong to the broader category of "world-dominant fictions," as opposed to "story-dominant fictions" (Ryan, 2014). It is also important to note that our understanding of fictions with imaginary worlds is very close to the category of "speculative fictions," which encompasses any fictional genre typically containing some background elements that do not exist in the real world (Table 1). Yet it does not totally overlap with it. Indeed, not all speculative fictions require extensive background information to be appreciated. For instance, Edgar Poe's and Franz Kafka's fantastic tales in which there is only one element of supernatural do not offer much to explore. The appeal of these speculative fictions, in which the world is either relatively unimportant or very similar to the real world, would rely on the blurring of the boundaries between what is real and what is unreal (Todorov, 2015). Nonetheless, speculative fictions, being recorded and tagged online, can be used as a proxy for fictions with imaginary worlds (Dubourg et al., 2021).

Fantasy and science fiction are recent fictional genres, but imaginary worlds are much more ancient (Scholes & Rabkin, 1977). A huge number of ancient fictions set an imaginary world, in ancient epic poems about heroes' journeys, travelers' tales from the exploration age, adventure fictions, utopias, and dystopias (Wolf, 2012). For instance, the ancient Mesopotamian *The Epic of Gilgamesh* (1800 BCE) and *The Odyssey* (850 BCE) are often mentioned as precursors of fantasy fiction. Some scholars have tried to map the faraway lands and islands visited by Odysseus (Clay, 2007). Other imaginary locations from this period were directly described without any narration (e.g., Arimaspi, the imaginary world from Herodotus' *Histories*). Lucian of Samosata's *True History* is evidence that such travelers' tales from this ancient time were considered as imaginary by their audience, as it is clearly stated in the Introduction: "I see no reason for resigning my right to that inventive freedom others enjoy […]. My subject is, then, what I have neither seen, experienced, nor been told, what neither exists nor could conceivably do so. I humbly solicit my readers' incredulity" (Lucian of Samosata, 150 C.E.). Other ancient imaginary worlds are mentioned to strengthen this argument (Table 2).

All these suggest that, in fictions, imaginary worlds are highly appealing. It raises several questions. Why this urge to create new fictional locations from scratch? The same stories could take place in faithful representations of the real world and it would considerably reduce the costs of fiction making (e.g., economic costs related to special effects in films with imaginary worlds). Why are we captivated by fictions with imaginary worlds, and seemingly more and more so? The timing of their success suggests that we are more predisposed to appreciate such fictions in modern societies, or we would have invented more imaginary worlds much earlier. Why are best-rated video games those with large open worlds (e.g., *Zelda*, *Assassin's Creed*, and *No Man's Sky*)? Why Baum (*The Wizard of Oz*), Tolkien (*The Lord of the Rings*), Lucas (*Star Wars*), Cameron (*Avatar*), Rowling (*Harry Potter*), and developers from Hello Games Studio (*No Man's Sky*), to name only a few, were willing to devote multiple years of their lives building extensive imaginary worlds? In a nutshell: Why imaginary worlds?

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Table 2. (Dubourg and Baumard). Examples of imaginary worlds in non-contemporary fictions, with their invented toponyms, extracted from the broadly inclusive list of imaginary worlds put forward by Wolf (2012)

Location name	Title	Author	Date	Region
Anpu's Country	*Tale of Two Brothers*	Undetermined	1200 BCE[a]	Egypt
Odysseus Islands	*The Odyssey*	Homer	900 BCE[a]	Greece
Islands of the Sun	*Islands of the Sun*	Iambulus	100 BCE[a]	Greece
Island of Anostus	*Varia Historia*	Claudius Aelianus	175[a]	Rome
The Otherworld	*The Voyage of Bran*	Undetermined	750[a]	Ireland
Magical islands	*Sinbad the Sailor*	Undetermined	800[a]	Middle East
The Moon	*The Tale of the Bamboo Cutter*	Undetermined	950[a]	Japan
Brocéliande	*Yvain, the Knight of the Lion*	Chrétien de Troyes	1180	France
Cockaigne	*Le Dit de Cocagne*	Undetermined	1250[a]	France
Hell	*The Divine Comedy*	Dante	1321	Italy
Devil's Island and other islands	*Amadís de Gaule*	Undetermined	1508	France
Utopia	*Utopia*	Thomas More	1516	England
Prospero's Island	*The Tempest*	William Shakespeare	1623	England
Lilliput, Laputa, Brobdingnag, etc.	*Gulliver's Travels*	Jonathan Swift	1726	Ireland

[a]Dates are approximative.

3. The psychological foundations and cultural evolution of fictions

To understand the human's interest in imaginary worlds, we first need to clarify why humans produce and consume fictions. At the proximate level, evolutionary and cognitive approaches to fictions have demonstrated that fictions tend to recycle and exaggerate the most attention-grabbing and fitness-relevant stimuli in real life (Boyd, 2018; Carroll, 2012; Gottschall, 2012; Gottschall & Wilson, 2005; Mar & Oatley, 2008; Saad, 2012; Schaeffer, 1999), such as romantic relationship (Alberti, 2013; Baumard, Huillery, & Zabro, in press; Cox & Fisher, 2009; Martins & Baumard, 2021; Salmon & Symons, 2004; Vanderbeke, 2019), cooperation and cheating (Singh, 2021), social status (Nettle, 2005a, 2005b), and political rivalries (Jobling, 2001). In other words, fictions constitute "intensified stimuli" or "superstimuli" in the sense that they are crafted to artificially grab the consumers' attention, just like masks artificially trigger the human face detection capacity, and cuisine artificially triggers the nutrients detector systems (Boyer, 2018; Buss, 2015; Nettle, 2005a; Sperber, 1996; Sperber & Hirschfeld, 2004; Verpooten & Nelissen, 2010). Triggering people's attention is indeed the most important element of success of fictions. Such an evolutionary and cognitive approach of fiction, therefore, predicts that to answer the question "Why do people enjoy fictions?" is very close to answering the question "Why do people enjoy life?" (Bloom, 2010; Pinker, 1997).

A common view in behavioral sciences is that the capacity to tell stories is adaptive. This capacity would have evolved either to convey and teach new information (Sugiyama, 1996, 2001) or to simulate the real world (Mar & Oatley, 2008; Morin, Acerbi, & Sobchuk, 2019; Zunshine, 2006). Here, we rather assume that humans did not specifically evolve the capacity to tell stories, but they rather create fictions thanks to a range of other adaptations (e.g., language, capacity to simulate, and theory of mind; Mellmann, 2012). Yet, because they are highly attractive, fictions can be used to fulfill any evolutionary relevant purpose that needs others' attention to be caught, be it signaling one's values to potential mates (Miller, 2001) or cooperative partners (André & Baumard, 2020; André, Baumard, & Boyer, 2020; Bourdieu, 2010; Nettle, 2005b; Singh, 2020; 2021; Veblen, 1899), transmitting knowledge (Nakawake & Sato, 2019; Schniter, Wilcox, Beheim, Kaplan, & Gurven, 2018; Sugiyama, 2021), communicating social norms (Ferrara, Banerjee, & Orozco, 2019; Mar & Oatley, 2008), or selling products (Saad, 2012; Saad & Gill, 2000). Thus, to use a standard term, we do not consider fictions as "by-products," because they clearly confer benefits to both the producers and the consumers (André et al., 2020). At the same time, fictions are definitely artificial. Hence, it is probably more appropriate to say that fictions (e.g., novels, films, and video games) are a kind of cultural technology primarily designed for entertainment (Dubourg & Baumard, in press; Singh, 2020).

To conclude, because we hypothesize that fictions are created mostly to attract attention, we do not hypothesize that there is any specific value in the information included in *The Lord of the Rings* or in *Harry Potter*. Imaginary worlds, we propose, are appealing because they meet the "input conditions" of our cognitive dispositions geared toward exploration (Sperber & Hirschfeld, 2004), just as romances and tragedies meet the input conditions of our preferences for love and social competition (Nettle, 2005a, 2005b). Because fiction makers can intensify such attention-grabbing stimuli in the fictions, they grab our attention, even if the information is totally useless in real life.

Obviously, fictions tap into several kinds of human interests and our paper is about just one of them. Thus, our paper does not suggest that everybody should prefer fictions with imaginary worlds. A parallel can be made with cuisine: Sugar is clearly an important cultural attractor in the cultural evolution of recipes, but not all recipes include sugar and not everybody likes candies and pastries. In other words, although some people prefer consuming fictions about familiar places and comforting stories, others would preferably consume fictions with imaginary worlds and adventurous journeys. In the next section, we will argue that

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

this variability in cultural preferences is evoked by the variability in the strength of exploratory preferences at the individual level.

4. The evolution and psychology of exploratory preferences

Our hypothesis is that the cultural preference for imaginary worlds relies on our exploratory preferences, driving our motivation to explore novel environments. As Tolkien put it himself, "part of the attraction of *The Lord of the Rings*," and other fictions with imaginary worlds, relies on the "intrinsic feeling of reward" we experience when "viewing far off an unvisited island or the towers of a distant city" (letter to Colonel Worskett, September 20, 1963). This statement is very close to the one of Shigeru Miyamoto, the creator of *Zelda*, who reported that he "wanted to create a game world that conveyed the same feeling you get when you are exploring a new city for the first time" (1989). Such fictions would, thus, "tap into that deeply-seated human desire to travel, seek out new experiences, and absorb new knowledge about the world" (Etchells, 2019). In this section, we explain further the ultimate and proximate mechanisms behind exploratory preferences.

4.1. The evolution of exploratory preferences and capacities: the fitness benefits of exploration

From an evolutionary point of view, there is a broad consensus to say that exploring the environment is especially adaptive for mobile species, as it leads to discovering new vital resources such as food, finding mates and habitats, avoiding predators, and learning new action–outcome associations (Cashdan & Gaulin, 2016; Chambon, Thero, Findling, & Koechlin, 2018; Gottlieb & Oudeyer, 2018; Hayden & Niv, 2020; Hewlett, van de Koppel, & Cavalli-Sforza, 1982; Hills, 2006; MacDonald & Hewlett, 1999; Miner, Gurven, Kaplan, & Gaulin, 2014; Panksepp, 2005). For several species in several ecologies, such benefits outweigh to a certain point the costs of exploration (e.g., energetic loss, economic costs, risks of injury, and opportunity costs). Humans were particularly shaped by this selection pressure. Long-distance dispersal has been an important component of human migrations, allowing fast colonization of new territories all over the planet (Alves et al., 2016). Moreover, during the majority of its evolutionary history, *Homo sapiens* led a nomadic way of life (Lee, 1966), similar to several other species who are known to travel across space (Chapman et al., 2014).

In line with the idea that there are fitness benefits derived from spatial exploration, studies have shown that nonhuman animals are endowed with specific capacities to explore their environment, recall the location of resources, determine the best navigation route between resources, and reorient when approaching locations from new perspectives (Rosati & Hare, 2012). Importantly, these capacities vary according to the ecology of the species (Healy, Dekort, & Clayton, 2005; Platt & Brannon, 1996; Rosati, Rodriguez, & Hare, 2014). For instance, chimpanzees exhibited more accurate spatial memory than bonobos across contexts, supporting predictions from these species' different feeding ecologies: wild chimpanzees depend more on patchily distributed fruit, whereas bonobos depend more on homogeneously distributed resources such as terrestrial herbaceous vegetation (Rosati & Hare, 2012). Fishes' spatial behavior too is very flexible, and this plasticity would rely on homologous cognitive mechanisms as those identified in mammals and birds (Broglio, Rodríguez, & Salas, 2003). Importantly, these adaptations are not limited to purely cognitive capacities; they also extend to reward orientation. For instance, tamarins who feed on an ephemeral, dispersed food source (e.g., insects) and travel through large territories are much more likely to travel to a smaller, closer reward or a larger, more distant reward than marmosets who feed on a localized, immobile food (gum and sap exuding from trees) and, consequently, face little pressure to travel long distances for food (Stevens, Rosati, Ross, & Hauser, 2005).

Finally, it is important to note that such cognitive capacities are hypothesized to be the evolutionary precursor to goal-directed cognition: Several disciplines ranging from behavioral ecology to molecular genetics provide evidence that, for instance, problem-solving is a cognitive system born out ancient space-foraging behaviors (Hills, 2006; Hills & Stroup, 2004; Hills, Todd, & Goldstone, 2010). Such capacities are shared across all mobile organisms. Fishes' spatial behavior, for instance, is as elaborate as the ones of land vertebrates (Broglio et al., 2003). Even further away from humans in the phylogenetic tree, bacteria's attempts to go back to resourceful environments through turns after removal from food is a strategic-foraging behavior (Korobkova, Emonet, Vilar, Shimizu, & Cluzel, 2004; Neidhardt & Curtiss, 1996). In humans, cognitive maps are applied to non-spatial domains such as conceptual thinking (Behrens et al., 2018; Epstein, Patai, Julian, & Spiers, 2017; Jacobs, 2003), and exploratory preferences are rallied to domain-general decision-making processes (Daw, O'Doherty, Dayan, Seymour, & Dolan, 2006; Hills et al., 2010; Le Heron et al., 2019). Crucially, there is empirical evidence that preferences for spatial exploration in foraging tasks are correlated with preferences for cognitive exploration in problem-solving tasks (Hills & Stroup, 2004).

4.2 The behavioral manifestations of exploratory preferences: animal exploration, wayfinding, and environmental esthetics

Such preferences for spatial exploration are blatant when studying animal behavior. Several experimental studies revealed how curious about novel environments animals can be. In a famous study, rats were found to spend more time exploring novel environments than exploiting familiar ones (Berlyne, 1950). Since then, the novelty-based theory of exploration and curiosity has been supported by several studies in the nonhuman animal literature, with various empirical tests, from the "open-field arena" test for mice (Berlyne, 1970; Peeler & Nowakowski, 1987) to the "visual novelty preference" test for monkeys (e.g., Fagan, 1970; Gunderson and Sackett, 1984). Rats can learn to find their way around a maze in the absence of rewards (Byrne, 2013; Reed & Adams, 1996), suggesting that the opportunity to explore is intrinsically rewarding (Sabbatini et al., 2014). Rats and pigeons prefer multiple-choices paths over no-choice, shorter paths leading to the same reward (Bown, Read, & Summers, 2003; Catania, 1980; Catania & Sagvolden, 1980; McDevitt, Pisklak, Spetch, & Dunn, 2018). More recent studies with two-choice tests showed that animals are more interested by unfamiliar objects compared to familiar ones. At this stage, it has been proved to be the case for bottlenose dolphins, Pacific white-sided dolphins, beluga whales (Guarino, Yeater, Lacy, Dees, & Hill, 2017), rhesus macaques (Englerova, Klement, Frynta, Rokyta, & Nekovarova, 2019; Wang & Hayden, 2019), and orangutans (Borel, Ajzenherc, Moncel, Saint Jalme, & Krief, 2016). Also, it is worth noting that exploration is still preferred when the payoff is removed: In so-called non-instrumental tasks, animals observe novel stimuli

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

even if they cannot act on them (Gottlieb & Oudeyer, 2018). More surprisingly, exploration is attractive to the point that animals are willing to pay a supplementary cost to keep exploring (FitzGibbon, Lau, & Murayama, 2020; Hughes, 2007; Oudeyer, Gottlieb, & Lopes, 2016).

In humans, one obvious place to look for exploratory preferences is studies of wayfinding. Wayfinding is generally defined as the ability to move around efficiently and find the way from a starting point to a destination (Montello, 2005). It is different from pure locomotion. Locomotion depends on sensory-motor systems interacting with an immediate surrounding, whereas wayfinding invokes higher-level cognitive systems to maintain orientation relative to the distal environment. Experimental research has shown that performance in wayfinding is predicted by both cognitive capacities (e.g., visuospatial memory and mental rotation ability) and individual preferences. For instance, individuals who take pleasure in exploring places tend to have a good sense of direction (Muffato, Toffalini, Meneghetti, Carbone, & De Beni, 2017) and perform better in spatial tasks (Carbone, Meneghetti, & Borella, 2020; Muffato, Meneghetti, & De Beni, 2016, 2017). In particular, Pazzaglia, Meneghetti, and Ronconi (2018) showed that a significant part of the variability in the performance was explained by an aggregate measure of pleasure in exploring. Interestingly, the strength of the relationship between preferences and wayfinding tasks seems to depend on how difficult the task is: the tougher the task, the stronger the relationship (Pazzaglia et al., 2018; Weisberg, Schinazi, Newcombe, Shipley, & Epstein, 2014).

Another area of research is known as "environmental esthetics," a domain of empirical psychological research which investigates the elements of settings to which people are attracted the most (Balling & Falk, 1982; Falk & Balling, 2010; Herzog, 1984; 1985; Herzog & Bryce, 2007; Herzog & Smith, 1988; Ikemi, 2005; Kaplan, 1988; Kaplan & Kaplan, 1989; Ruso, Renninger, & Atzwanger, 2003; Ulrich, 1979). Scholars working in environmental esthetics have conducted a great number of experimental studies to investigate the existence and the nature of universal preferences regarding environments. One of the key findings of this research program is that environments and landscapes are typically better rated and thus preferred when the settings signal an opportunity to gather information through exploration (e.g., the picture shows a trail that disappeared around a corner). Therefore, what makes an environmental setting appealing is the promise of further novel information, causally inferred from cues indicating that an enrichment in knowledge is a possibility. It is important to note here that these preferences are said to be automatic, unconscious, and intuitive. More often than not, participants were unable to explain their choices when rating the landscapes (Kaplan, 1987), sustaining the hypothesis that sometimes "preferences need no inferences" nor explicit judgments (Zajonc, 1980).

4.3. The cognitive and neural mechanisms underpinning exploratory preferences: plasticity, the exploitation–exploration trade-off, and the dopamine system

The study of wayfinding abilities and environmental preferences demonstrates the existence of specific preferences for spatial exploration. Exploratory preferences are part of a broader set of personality traits related to the meta-trait "plasticity." The trait plasticity reflects the degree to which an organism is prone "to generating new goals, new interpretations of the present state, and new strategies to pursue existing goals" (DeYoung, 2013, 2015). Behavioral plasticity and exploratory preferences are inseparable notions because spatial exploration requires to be able to flexibly adapt to changing environments, otherwise exploration is too costly (Rojas-Ferrer, Thompson, & Morand-Ferron, 2020; Sol, Sayol, Ducatez, & Lefebvre, 2016). From an empirical perspective, exploratory preferences are best studied through two important constructs that are highly correlated (DeYoung, 2015; George & Zhou, 2001; Gocłowska, Ritter, Elliot, & Baas, 2019; Gottlieb, Oudeyer, Lopes, & Baranes, 2013; Li et al., 2015; McCrae, 1993): (1) the Big Five trait Openness to experience in personality psychology (e.g., Carbone, Meneghetti, and Borella, 2019, 2020; Meneghetti, Grimaldi, Nucci, & Pazzaglia, 2020; Pazzaglia et al., 2018) and (2) novelty-seeking in the neuroscience of decision-making (e.g., Costa, Tran, Turchi, & Averbeck, 2014; Krebs, Schott, Schütze, & Düzel, 2009). It is worth noting that wayfinding inclinations have been shown to be positively associated with Openness to experience (Carbone et al., 2020; Meneghetti et al., 2020).

To further understand how exploratory preferences work at the proximate level, researchers designed the "bandit" task and its variants (Schulz & Gershman, 2019): In its most basic design, the learner must choose between pulling a lever with known but degressive reward (i.e., to exploit) or a lever with unknown payoff, which is the exploratory choice (Cohen, McClure, & Yu, 2007; Daw et al., 2006; Gershman, 2018; Le Heron et al., 2019). It has been found that humans use a combination of both directed and random exploration strategies, with novelty cues as informative "bonuses" (Chakroun, Mathar, Wiehler, Ganzer, & Peters, 2020; Gershman, 2018; Gottlieb & Oudeyer, 2018; Schulz & Gershman, 2019; Wilson, Geana, White, Ludvig, & Cohen, 2014). The exploitation–exploration trade-off is a classic problem in reinforcement learning. It corresponds to an evolutionary dilemma all mobile organisms face: They constantly need to arbitrate between exploiting a well-known (but maybe decreasing) source of resources or explore to find unknown (but maybe better) opportunities (Mehlhorn et al., 2015). The computational theory of reinforcement learning claims that the high-level goal of any learning agent is to obtain as much reward as possible, even if it is delayed (Dubey & Griffiths, 2020; Gozli, 2018) and it supports the idea from behavioral ecology that knowledge acquisition, prompted by novelty-based exploration, aims at optimizing future rewards (Brändle, Wu, & Schulz, 2020; Dubey & Griffiths, 2020; Oudeyer et al., 2016).

The study of animal exploration in the previous sub-section suggested that rewards associated with exploratory behavior are different from and independent of external rewards present in the environment. Thus, across species, it is generally accepted that there is an intrinsic motivation to explore novel environments (Gottlieb et al., 2013; Gottlieb & Oudeyer, 2018; Liquin & Lombrozo, 2020a, 2020b). What are the neural bases for this intrinsic motivation to explore? There is persistent evidence that the dopamine system, known to be at the basis of rewards across several species (e.g., Baumann, Dames, Kühnel, and Walz, 2002; Hills, 2004; Schultz, 1998, 2015), reacts specifically to novel stimuli which do not involve any primary reward (Düzel, Bunzeck, Guitart-Masip, & Düzel, 2010; Horvitz, Stewart, & Jacobs, 1997; Kakade & Dayan, 2002; Reed, Mitchell, & Nokes, 1996). Data from experiments with injections of a selective dopamine transporter inhibitor show that dopamine crucially enhances novelty-related value (Costa et al., 2014). A pivotal event-related functional magnetic resonance imaging (fMRI) study has demonstrated that novel pictures activated the mid-brain substantia nigra

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

and ventral tegmental area (SN/TVA) more than rare, arousing and behaviorally relevant pictures (Bunzeck & Düzel, 2006). That is, in the absence of reward, the dopamine system is activated by novel stimuli rather than interesting but more familiar ones. This finding supports the idea that "novelty can serve as its own reward" (Knutson & Cooper, 2006) and is very much in line with the novelty-based theory of exploration (Bromberg-Martin, Matsumoto, & Hikosaka, 2010; Gottlieb & Oudeyer, 2018; Kidd & Hayden, 2015). Interestingly, the reaction of the dopamine system to novel stimuli has been interestingly referred to as "novelty bonuses" (Frank, Doll, Oas-Terpstra, & Moreno, 2009; Kakade & Dayan, 2002; Koster, Seow, Dolan, & Düzel, 2016; Krebs et al., 2009; Krueger, Wilson, & Cohen, 2017; Sutton, 1990). Finally, empirical results from fMRI studies also show that, although the neuronal system coding for novel information-seeking behavior recruits the dopamine-based reward system, non-explorative choices (i.e., exploiting existing information) recruit different brain regions (Blanchard & Gershman, 2018; Chakroun et al., 2020; Costa, Mitz, & Averbeck, 2019; Daw et al., 2006). Exploration, therefore, accounts for a specific neuronal and cognitive domain (Blanchard & Gershman, 2018).

4.4. The variability of exploratory preferences: life stage and ecological conditions

Finally, we go back to the ultimate level, to explain why and how such exploratory preferences are flexible, and vary according to the local environment and the life stage of the individual (Baumard, 2019; Frankenhuis, Panchanathan, & Nettle, 2016; Jacquet, Safra, Wyart, Baumard, & Chevallier, 2019; Nettle, 2019). Indeed, behavioral sciences have shown that organisms flexibly allocate resources such as energy and time to spatial exploration in a way that maximizes biological fitness (Charnov, 1976; Kaplan & Gangestad, 2015; Stephens, Brown, & Ydenberg, 2014). More specifically, all foraging species face an exploration–exploitation trade-off, that is, the dilemma between choosing either an exploitative or an exploratory option, be it for spatial foraging, choice making, or problem solving (Hills, Todd, Lazer, Redish, & Couzin, 2015; Mehlhorn et al., 2015). Therefore, the strength of exploratory preferences should vary according to ecological conditions (because the costs and benefits of exploration depend on the resources of the environment) and the life stage (because the costs and benefits of exploration vary with one's life stage).

4.4.1. Exploratory preferences and life stages

In several animals, individuals' life stage impacts their exploratory strategy: Typically, they go through an early period of exploration followed by a later period of exploitation (Cohen et al., 2007; Morgan, Suchow, & Griffiths, 2020; Stansfield & Kirstein, 2006). This is the case because exploration is most adaptive when the individual knows little about the world, and juveniles from all species have less knowledge compared to adults (Blanco & Sloutsky, 2020, 2021). But juveniles from different species don't explore at the same rate or to the same extent. We argue that species with parental care explore more because the major costs associated with exploration (e.g., resource shortage risk) are outweighed by parental caregiving investments. Humans are a case in point here because human's juvenile period is longer than in any other species and allows for a long early protected period which can be devoted to cognitive and spatial exploration (Del Giudice, 2014; Kaplan & Gangestad, 2015). In fact, studies have shown that although chimpanzees start being autonomous around 3 years old, individuals in modern hunter–gatherers societies are still dependent on their parents and kin up until 25 years old for feeding and protection (Bogin, 1997; Kaplan, Hill, Lancaster, & Hurtado, 2000). This suggests that, although primates need to stop exploring very early on, human children can continue to play, learn, and explore their environment for a very long period of time before reaching puberty (Del Giudice, 2014). Researchers agree that human's prolonged childhood is central to our unique intelligence (e.g., Gopnik et al., 2017; Piantadosi and Kidd, 2016; Tomasello, 2019).

Several evolutionary anthropologists and developmental biologists argue that this extended childhood stage is, in fact, a pivotal human adaptation. This life stage would have evolved in humans so that juveniles could have had the opportunity to acquire new foraging skills (Kaplan et al., 2000; Kaplan & Robson, 2002), social skills (Flinn & Ward, 2005), spatial skills (Piccardi, Leonzi, D'Amico, Marano, & Guariglia, 2014), and reasoning skills (Buchsbaum, Bridgers, Skolnick Weisberg, & Gopnik, 2012). Therefore, skill learning would be the primary function of this long-lasting life stage. It can only work because, in return, older individuals compensate for the low productivity of juveniles with huge investments of time and resources (Kaplan et al., 2000). It can be seen as an adaptive feedback loop or as an adaptive developmental division of labor (Buchsbaum et al., 2012; Gopnik, 2020; Gopnik et al., 2017; Kaplan et al., 2000; Sumner, Steyvers, & Sarnecka, 2019b). Such learning advantages of the extending childhood life stage explain why it evolved despite the heavy evolutionary costs associated with late reproduction.

In behavioral and cognitive sciences, much experimental evidence supports this idea. First, there is evidence that parental investments make early exploration possible: Cues of parental support or even the mere presence of a parental figure enhance exploratory behavior in children (Belsky, Goode, & Most, 1980; Rubenstein, 1967; Snell-Rood & Snell-Rood, 2020; Tottenham, Shapiro, Flannery, Caldera, & Sullivan, 2019). Second, in some circumstances, children are more motivated to explore or better skilled at exploration compared to adults. From early in development, children seek causal explanations by asking questions about their environments (Liquin & Lombrozo, 2020a, 2020b). Younger children explore alternative uses of a tool more than older children (Defeyter & German, 2003) and explore more flexibly alternative hypothesis compared to older children and even adults in problem-solving tasks (Gopnik et al., 2017). Finally, children spend significantly longer time exploring their environments and explore at a higher rate than adults do (Blanco & Sloutsky, 2019, 2021; Gopnik et al., 2017; Schulz, Wu, Ruggeri, & Meder, 2019; Sumner et al., 2019a, 2019b).

To take one example, in an experiment with two sources of reward, children of age 5–12 collected fewer rewards compared to adults because they explored more (i.e., they switched more between the two sources of reward, even though one had higher payoffs), but, on the contrary, they were significantly more likely to detect an important change in reward opportunities, that a majority of adults missed because of their exploitative strategy (Sumner et al., 2019a; on the costs of selective attention, see Blanco & Sloutsky, 2019; on learning traps, see Rich & Gureckis, 2018). The same kind of experimental design and the same results have been found with children doing a bandit task (Sumner et al., 2019b), a reinforcement learning task (Liquin & Gopnik, 2019), and a change-detection task (Plebanek &

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Sloutsky, 2017): Children outperform adults because the latter missed information that children got through prolonged exploration. These results suggest that adults maximize payoffs at the cost of exploration and that, conversely, children invest more in exploration and thus miss fewer learning opportunities (Blanco & Sloutsky, 2019).

Finally, further experimental research showed that children learn more from exploration compared to adults (Bonawitz, van Schijndel, Friel, & Schulz, 2012; Sim & Xu, 2017a). For instance, experimental research in cognitive developmental psychology showed that children learn new, unexpected, or unusual causal relationships better (e.g., more rapidly, with fewer events) than adults do (Gopnik, Griffiths, & Lucas, 2015, 2017; Lucas, Bridgers, Griffiths, & Gopnik, 2014; Sim & Xu, 2017b).

4.4.2. Exploratory preferences and ecological conditions

Adaptive plasticity is the idea that individuals can adaptively express a range of different phenotypes depending on the state of the local ecology (Baumard, 2017; Frankenhuis & Nettle, 2020). More specifically, natural selection has favored psychological preferences that can flexibly adapt to different environments, so that the behavioral "programs" associated with such preferences maximize fitness in each of them. We argue that a substantial part of the variability in exploratory preferences, across time and populations, can be explained with adaptive plasticity. If exploration is more beneficial and less costly in some environments than in others, natural selection should have favored the expression of stronger exploratory preferences in such environments.

This is what behavioral ecologists commonly observe. Across species, exploration is sensitive to the level and steadiness of resources in the local environment (English, Fawcett, Higginson, Trimmer, & Uller, 2016; Humphreys et al., 2015). For instance, studies with rats showed that exploratory behavior decreases with adversity in life (Spivey, Barrett, Padilla, & Gonzalez-Lima, 2008). The same results have been found in other species such as black-capped chickadees (Rojas-Ferrer et al., 2020), 61 different parrot species (Mettke-Hofmann, Winkler, & Leisler, 2002), vampire bats (Carter, Forss, Page, & Ratcliffe, 2018), honeybees (Katz & Naug, 2015), wild-spotted hyenas (Benson-Amram & Holekamp, 2012), and orangutans (Damerius, Graber, Willems, & van Schaik, 2017; van Schaik et al., 2016). This is also true in humans, who innovate and are more creative and opened to new experiences in affluent and safe societies (Baumard, 2019; Inglehart, 2018). Empirical studies on human behavior have consistently supported this hypothesis: Individuals with high and steady levels of resources are more ready to explore novel information and new rewards (Frankenhuis et al., 2016; Jacquet et al., 2019; Nettle, 2019). In sum, several species including humans become more exploratory under the condition of relative safety.

These findings are best explained by the level of risks raised by exploratory behavior in different ecologies. In unsafe and poor ecologies, exploration is very risky, notably because if exploration doesn't pay off, one is left with nothing. Relatedly, the opportunity costs of exploration are higher in scarcity because one is better off providing for more pressing needs. Conversely, in more affluent and safer ecologies, such risks are lower: When surrounded by more resources, individuals can afford to lose some of them in the short term (Baumard, 2019). For instance, field observations suggest that wild orangutans avoid novelty whereas zoo orangutans are a lot more curious and explorative, with the very same tests. This contrast is best explained by the ecological differences between the two environments: Captive apes are fed and protected, and the risks of exploration such as resource shortage or predation are removed (Damerius et al., 2017; van Schaik et al., 2016). In line with this idea, there is much evidence that animals adaptively reduce their exploration rate as predation risk increases (Verdolin, 2006).

The example of the risk of resource shortage is another good test case here. Spatial exploration for foraging involves several risks related to resource collection. More specifically, it involves crucial opportunity costs such as waiting costs, that is, the costs associated with delayed (as opposed to immediate) collection of resources (Boon-Falleur, Baumard, & André, 2020; Mell, Baumard, & André, 2021). Multiple optimal foraging models emphasize the discrepancy between the immediate risks of an exploratory strategy (e.g., the decrease of the resource levels during search time) and the positive value of the acquired information for future exploitation (e.g., Eliassen, Jørgensen, Mangel, & Giske, 2007; Maspons, Molowny-Horas, & Sol, 2019). In fact, exploration is best seen as an investment which is costly in the short term but beneficial in the long term, that is, a risky investment that organisms should only "prefer" to make in safe and affluent ecologies.

This line of argument suggests that it is only in an affluent environment that humans should afford to invest more in unpredictable exploratory activities (Baumard, 2019). It is also true if we consider the cultural evolution of human societies. It is well-established that, during the twentieth century, economic development is associated with more tolerance, more optimism, more interest in science, and less interest in religion (Inglehart, 2018; Norris & Inglehart, 2004). Similar observations can be made over the longer term: Economic development in ancient societies is associated with more tolerance (Martins & Baumard, 2020; Safra, Chevallier, Grèzes, & Baumard, 2020) and more exploration (Baumard, 2019; de Courson & Baumard, 2019). To sum up, when resources are high, exploration is less risky and, thus, more likely to be advantageous. Therefore, under such conditions, phenotypic plasticity adaptively promotes and enhances exploratory preferences.

5. Exploratory preferences explain the cultural distribution of imaginary worlds

Although preferences for exploration are a human universal, the strength of exploratory preferences varies greatly from one individual to another. In this section, we argue that the variability in exploratory preferences partly explain individual differences in the preference for fictions with imaginary worlds, and therefore the cultural distribution of imaginary worlds across time, space, and population. We derive three predictions from this idea: (1) fictions with imaginary worlds should be more attractive to people high in Openness to experience, a personality trait measure used as a proxy for exploratory preferences, (2) younger individuals, for which exploration is less costly and more advantageous, should be more drawn to imaginary worlds compared to older individuals, and (3) individuals living in more affluent environments, where exploration is less risky and more adaptive, should have higher preferences for imaginary worlds.

5.1 Imaginary worlds should be more attractive to people higher in Openness to experience

If imaginary worlds co-opt our exploratory preferences, the appeal for imaginary worlds should be associated with Openness to experience, a component of the "Big Five" related to exploratory preferences (Carbone et al., 2020; Meneghetti

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

et al., 2020). This is indeed the case. In a recent paper, Nave, Rentfrow, and Bhatia (2020) studied the association between personality traits and the "liking" of movies in Facebook users ($N = 3.5$ million). Using the same dataset, we show that higher scores in Openness to experience are associated with a preference for imaginary worlds (Dubourg et al., 2021). It is worth noting that, by contrast, fictions with imaginary worlds are associated with lower levels of extraversion, conscientiousness, agreeableness, and neuroticism (Dubourg et al., 2021).

Because Openness to experience is positively correlated with intellectual curiosity and higher academic achievement (Hakimi, Hejazi, & Lavasani, 2011; Sorić, Penezić, & Burić, 2017), it can be further predicted that people with a preference for fictions with imaginary worlds should have higher academic achievement. This is also the case. Consumers of fictions with imaginary worlds seem to be highly educated, compared to the general population. For instance, 82.4% of the survey with science fiction and fantasy fans report being educated to the university level or above (Menadue & Jacups, 2018). This compares to 46% of the United States population, 50% of Australians, and 46% of the United Kingdom population (Organization for Economic Co-Operation and Development, 2017). This reinforces previous audience data that found "astonishing" high levels of education among the science fiction readership (Berger, 1977, p. 236). Future research could notably test whether people who preferably consume fictions with imaginary worlds also preferably read informative non-fiction books, as well as other world-dominant fictions such as historical novels.

Openness to experience is also associated with more exploration in the social domain. People high in Openness to experience are indeed more likely to be tolerant of diversity, liberal, opened to new lifestyles, and opposed to right-wing political orientations (Butler, 2000; Sibley & Duckitt, 2008). We, thus, predict that people who like imaginary worlds should be, overall, more politically tolerant, and socially liberal. This reasoning also predicts that people who enjoy imaginary worlds should prefer fictions exploring new social roles (Mar, 2018; Mar & Oatley, 2008). In line with such predictions, recent research has observed that fans of fictions with imaginary worlds are more politically progressive and committed against prejudice (Besson, 2021). Future empirical research could test this prediction.

In sum, we hypothesize that the preferences for imaginary worlds should be associated with a cluster of cultural preferences (e.g., more progressive political opinions and higher consumption of informative essays and historical novels) associated with Openness to experience.

5.2. Imaginary worlds should be more attractive to children, teenagers, and young adults

In section 4.4.1, we reviewed research showing that children have stronger exploratory preferences compared to adults and, under some conditions, even explore more than adults. For instance, in multiple experiments, they explored longer and generalized information from fewer events. We showed that this extended life stage can, in fact, be seen an adaptation: Major costs associated with exploration are outweighed by parental investments, so that children can "afford" to be more explorative. We, thus, hypothesize that children are more attracted to fictions with imaginary worlds.

In line with this hypothesis, we commonly observe that humans develop an early interest for imaginary worlds. Psychological research has shown that, very early on, children produce imaginary worlds in their heads (Silvey & MacKeith, 1988; Taylor, Mottweiler, Aguiar, Naylor, & Levernier, 2020). More importantly, consumers of fictions with imaginary worlds are typically (and, according to our hypothesis, accurately) stereotyped as young (Besson, 2015; Jenkins, 1998; Proctor & McCulloch, 2016). For instance, young readers are targeted by massively consumed novels in the fantasy genre, sometimes adapted for the screen with unparalleled successes. Let's think of Tolkien's *The Hobbit* (1937), Horowitz's *Groosham Grange* (1988), Riordan's *Percy Jackson* (2005–2009), Rowling's *Harry Potter* (1997–2007), Pullman's *His Dark Materials* (1995–2000), Saint-Exupéry's *The Little Prince* (1943), and Colin's *Hunger Games* (2008–2020). All these highly successful books with their famous imaginary worlds are edited in the children's collections from the publishing houses. We can further illustrate this point by mentioning the Walt Disney Studios, the single most productive and lucrative studios for children films. It is commonly observed that a majority of Disney films is based on the exploration of imaginary worlds (Elza, 2014). For instance, in *Alice in Wonderland* (1951), Alice decides to explore Wonderland (as in the children novel by Lewis Carroll) and in *Peter Pan* (1953), Wendy and his two brothers decide to explore the imaginary world of NeverLand.

Empirical research partly confirmed this prediction. In a study on the correlation between literary taste patterns and social differentiation in Finland, age was the only variable which significatively decreased the liking of speculative fictions (a proxy for fictions with imaginary worlds; see sect. 2), whereas age had no such effect on other fictional genres (Purhonen, Gronow, & Rahkonen, 2009). In Dubourg et al. (2021), we found a significative and negative correlation between age and a preference for movies with imaginary worlds: such movies tend to be liked by younger people. To our knowledge, our approach is the only one that consistently explains this strong association between the preference for imaginary worlds and the age of consumers.

5.3. Imaginary worlds should be more attractive to people living in more affluent environments

In section 4.4.2, we have also shown that exploration is more adaptive in predictable and affluent ecologies, because of the risk variable involved in the exploration–exploitation trade-off. If the level of resources in the local environment is high and steady enough, individuals can afford to delay potential benefits and to take risks: they become more motivated to explore the real world. We, therefore, predict that, both at the level of the individual and at the level of societies, affluence is a good predictor of the preference for imaginary worlds.

This prediction is in line with empirical findings. A recent empirical survey ($N = 909$) provided insights about the socioeconomic status of science fiction and fantasy fans (Menadue & Jacups, 2018). To the question about the income satisfaction level, most respondents answered: "I do well enough" (54.1%), and 32% answered "I'm happy with what I have" or "I have more than I need." Such readers also have curious and open-minded psychological traits. For instance, 95.2% reported they found new and unfamiliar ideas easy to understand. Because this study is based on a selected sample, we lack data to compare these results with the socioeconomic status of readers of other fictional genres, but it still confirms that consumers of fictions with imaginary worlds fit this general prediction. In another study, in

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Finland, speculative fictions were found to be significantly more read by people with higher income, whereas income as a variable had no such effect on the consumption of other genres (Purhonen et al., 2009).

At the global level, our hypothesis predicts that imaginary worlds should be more popular and, therefore, emerge in economically more developed countries. In line with this idea, the very first imaginary world comparable in size to the real world, Tolkien's world Arda, is extremely recent. Before 1914 (the first developments of Arda by Tolkien), humans had long begun to produce and consume literary fictions, and they didn't lack any cognitive abilities that would have prevented them to invent large imaginary worlds with much background information. However, only a few stories had developed large imaginary worlds (e.g., Dante's Hell) and virtually none had been precisely described and mapped. We argue that the late appearance of imaginary worlds is explained by the evolution of the strength of exploratory preferences. For a long time, people's exploratory preferences were too weak to give rise to the production of imaginary worlds in fictions. Economic development made such preferences adaptive in some populations, and only then could imaginary worlds appear and be culturally successful.

In fact, modern imaginary worlds first appeared in the United Kingdom (Wolf, 2012), which was at the time the leading country in terms of GDP per capita (Bolt & van Zenden, 2020), and then mostly developed in the Euro-American sphere (e.g., France, the United States, and Germany) and in the 1950s in Japan. By contrast, although Jules Verne was first translated in Chinese in the early twentieth century and inspired Chinese writers to write science fiction and fantasy stories during the late Qing dynasty and early Republican era, fictions based on imaginary worlds remained marginal in the Chinese literature during the twentieth century (Jiang, 2013). Imaginary worlds started to become popular first in Hong-Kong and Taiwan, which started to develop in the 1970s, and really became mainstream in mainland China in the turn of the new millennium, that is, 20 years after the take-off of the Chinese economy (Song, 2013).

In a recent empirical study (Dubourg et al., 2021), we studied the evolution of the share of fictions with imaginary worlds in 11 countries, since the beginning of the nineteenth century, with data extracted from Wikidata ($N = 44{,}608$). In most countries, when GDP per capita increases, the share of fictions with imaginary worlds rises too. We also studied another indicator of success, namely the box-office of films with imaginary worlds in the United States (Dubourg et al., 2021). An indicator of the success of films with imaginary worlds (IWS indicator) was computed by subtracting, for a given year, the mean box-office of films with imaginary worlds and the mean box-office of films with no imaginary worlds, in the United States. This indicator is highly and positively correlated with the GDP per capita in the United States. It even becomes positive: Above a certain threshold of GDP, films with imaginary worlds generate more revenues than others do. It would be interesting to test whether the quantitative analysis of the success of films with imaginary worlds and its association with affluence indicators replicate in non-Western developed countries (e.g., Japan and Korea) and developing countries (e.g., India and Nigeria).

Finally, it is interesting to note that as societies become safer and more affluent, people seem to grow out of the fondness for imaginary worlds at a later and later age. We argue that this is the case because, in such local environments, people should afford to remain explorative longer. This would explain why a new target audience has recently emerged, the "young adults," with associated editorial collections (i.e., YA literature) often specialized in speculative fictions with imaginary worlds. Future empirical research could focus on this prediction that in more economically developed societies, across both time and space, the mean age of fans of imaginary worlds is higher. This hypothesis lays the ground for a more general research program in behavioral sciences on the longer hold of children cultural preferences in modern societies.

6. Exploratory preferences shape the content and form of fictions with imaginary worlds

We argued that human's exploratory preferences, determined by ecological conditions and the life stage of the individuals, explain the cultural distribution of imaginary worlds, that is, the individual differences in the preference for imaginary worlds, the timing of their appearance in cultural history, and the variability of their success across societies and across populations. In this section, we focus on modern and contemporary culture. We hypothesize that, as soon as fictions with imaginary worlds emerge as a competitive market, their form and content should be shaped by what best co-opt humans' exploratory preferences. The basic idea is that cultural items compete for the attention of audiences and, therefore, producers are likely to intensify appealing stimuli to increase the success of their works. For instance, Walt Disney's Mickey co-opts our visual preference for baby faces. It has been shown that the evolution of its design is driven by this preference: Across the last few decades, Mickey progressively became cuter, that is, more baby-like, with larger heads and more doting eyes (Gould, 2008; Hinde & Barden, 1985). Similarly, because films have competed for the attention of moviegoers since the beginning of cinema, they have undergone continual changes. For example, over time, films have gotten faster (shot lengths have decreased) and darker (luminance have decreased), to better grab the attention of the viewers and improve their engagement in the film (Cutting, Brunick, DeLong, Iricinschi, & Candan, 2011).

This "superstimulus" hypothesis (or "stimulus intensification" hypothesis) posits that, as soon as enough people were safe and rich enough that strong exploratory preferences emerged and made imaginary worlds culturally successful (i.e., after Second World War in Europe and North America), producers started to invent, selectively retain, and cumulatively refine features that best exploited exploratory preferences, to make their imaginary worlds more appealing than other ones. From this point, several predictions follow, two of which we detail in this section: across time, (1) information background should increase in fictions with imaginary worlds, and (2) more particularly, fictions with imaginary worlds should generate more and more "paratexts" (i.e., information devices that surround the fiction; Genette, 1997).

6.1. Fictions with imaginary worlds should generate more and more non-narrative background

At the ultimate level, the function of exploration is to accumulate new information and maximize the usefulness of knowledge for future rewards (see sect. 4.1). This means that any new information about the real world (e.g., the localization of a foraging site) and any device making such information easier to learn (e.g., navigation systems) should attract the human mind. If the appeal for imaginary worlds indeed exploits such exploratory preferences, fiction makers should target this evolutionary function by

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

generating, in their fictions, more and more apparently useful background information leading to a better grasp of the imaginary environment.

This prediction appears to be validated by the cultural evolution of imaginary worlds. First, as time goes by, imaginary worlds are more and more precisely detailed in literary texts (Wolf, 2021). Tolkien's world is a case in point. It is remarkable that never before in the history of literature had there been such a comprehensive imaginary world. Imaginary worlds existed in ancient literature (see Table 2), but they were never thoroughly described and documented. Since Tolkien, although, several imaginary worlds have been extensively developed with much information about the settings (Wolf, 2012). This observation is perfectly in line with our prediction: Now that humans' exploratory preferences are heightened, any piece of background information about the world becomes an even more interesting stimulus that fiction makers can target. Why would consumers memorize so well so much information that yet only applies to the imaginary world? For instance, fans of *Harry Potter* know Quidditch rules, fans of *Star Wars* know the names of the planets, fans of *Game of Thrones* know the geography of Westeros, and fans of *Pokémon* know the evolution of each specimen (e.g., Delle, 2015). Such a list of useless (but effective-seeming) pieces of information about imaginary worlds that hundreds of millions of people learn, retain, and debate about, could go on and on (Besson, 2015). A case in point: such information is not only memorized, but also organized and stored online by fans: There is a "fandom" encyclopedia-like website for each famous imaginary world. To take one salient example, the online encyclopedia about *Star Wars* had 167,792 pages at the time of writing this paper.

Because background information has become an attention-grabbing stimulus, it should be intensified in fictions, that is, it should eventually become a "superstimulus." This is what fiction makers do: They expand the amount of information made available for a given imaginary world. Wolf (2017b) defines the "size" of an imaginary world as "the number of world data describing it." Importantly, this should not be mixed up with the "scope" of an imaginary world, which is the extent of the space covered by the imaginary world (e.g., an imaginary village, an imaginary planet, etc.). An imaginary world can be large but poorly described and, conversely, small in scope but very dense in details. We can now refine our prediction by saying that, because of humans' exploratory preferences, imaginary worlds with more world data should be more successful at a given time and, therefore, world data should increase. In sum, the size of imaginary worlds should progressively be intensified, regardless of their scope. Therefore, our hypothesis posits that exploratory preferences explain why "we are drawn to master what can be known about a world which always expands beyond our grasp" (Jenkins, 2006).

This is a strategy largely observed in video games, which rapidly evolved to include open imaginary worlds that the players can freely explore with "sandbox" gameplay: The player is given a great degree of freedom in the gradual discovery of the world. A case in point: In most open-world video games, the map of the imaginary worlds is not revealed right away, and one of the player's goal is to unveil it (Bartle, 2004). This is also the case in films and novels. Imaginary worlds are never precisely described at once, for instance, at the beginning of the fiction. Rather, information about the other-worldly settings comes progressively as the narrative unfolds, keeping our curiosity alive. For instance, the *Star Wars* galaxy is composed of several environments that are revealed in the course of the story. Crucially, such planets, to which characters travel by high-speed spaceships, are highly different from one another (e.g., Tatooine is a desert planet, Dagobah is a jungle planet, and Hoth is an ice planet). Another option for producers of fictions is to add more world data in other fictions set in the same imaginary world (Besson, 2015; Wolf, 2021), and sometimes from different media platforms. This gives rise to transmedial imaginary worlds (Konzack, 2018; Rebora, 2016) and to media franchises (Besson, 2015). For instance, Rebora (2016) argued that fantasy is "the best fitting literary ground for any transmedial expansion." Let's note that among the 20 highest-grossing media franchises, more than half are fictions set in an imaginary world (Wikipedia, 2021).

To further test this prediction that background information about imaginary worlds increases and makes fictions with imaginary worlds more successful, one could further operationalize the quantity of world data about imaginary worlds and look at the evolution of this measure over time. To do this, one could use a semantic tool that encodes spatial structure of worlds from literary texts (Louwerse & Zwaan, 2009). It has already been done with Tolkien's Middle Earth (Louwerse & Benesh, 2012). If applied to enough literary fictions, this tool could measure the cultural evolution of the informational complexity of imaginary worlds.

6.2. Fictions with imaginary worlds should generate more and more paratexts

Information about imaginary worlds can be more or less organized. It can be transmitted in a natural way, as in everyday life, but it can also use artificial devices such as maps, lists, or genealogies that greatly increase our ability to manipulate, store, and organize vast amounts of information (Goody, 1986). We, thus, predict that information devices leading to a better grasp of the information embedded in fictions with imaginary worlds should be appealing and should, therefore, increase in number across recent time.

In line with this prediction, paratexts (Genette, 1997) such as maps, guidebooks, appendices, lists, family trees, footnotes, or glossaries recently emerged in fictions with imaginary worlds, and became rapidly mainstream (Saler, 2012). In particular, maps attract our attention because they deliver spatial information about imaginary worlds. The fictional map in Stevenson's *Treasure Island* (1881–1882), one of the first imaginary maps, is partly what drew consumers to this book (Wolf, 2012). This suggests that people at that time rapidly became curious with non-narrative fictional artifacts. Since then, a substantial and growing part of fantasy fictions is released with maps of the imaginary worlds (Ekman, 2013). Some maps, such as Thror's map in *The Hobbit* and the Marauder's map in *Harry Potter*, are used by the characters in the fictions. Even if a map is not provided by the producers of the fiction, some fans always compile spatial information in the fiction, create their own maps and put them online. This suggests that virtually all imaginary worlds have been mapped, be it by fiction makers or by fans. Maps are even more useful in open-world video games, because gamers interact with the game world (Haggard & Chambon, 2012; Nguyen, 2019; Tanenbaum & Tanenbaum, 2009). Such video games always include an interactive map which allows the players to find their way around the world (Akchelov & Galanina, 2016; Nitsche, 2008; Wolf & Perron, 2014).

But maps are not the only kind of information device made available by fiction makers to increase the appeal of their fictions. Fictions with imaginary worlds can also include informational texts, either in the fictions (e.g., the Encyclopedia Galactica in

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Foundations) or published after the release of the fiction as real-world books (e.g., *Pandorapedia*, James Cameron's encyclopedia of Avatar's imaginary world Pandora, and Harry Potter Schoolbooks). Such guidebooks can even be written by other people than the creator and still be successful (e.g., *Philip Pullman's His Dark Materials: The Definitive Guide* by Laurie Frost). They almost all contain, among other things, hierarchized information about creatures, locations, and plants, as well as family trees of the protagonists. This information is also widely available online, notably in the "fandom" encyclopedias. "Pottermore" is yet another illustration of this trend: Rowling herself created a website for the sole purpose of providing more background information about the "Wizarding World" of Harry Potter. Finally, guidebooks for video games are highly successful worldwide. For instance, the guidebook to *Final Fantasy VIII* is an actual best-seller, with 2.2 million sold copies over the world. It is part of the Japanese guide series Square Enix companion books, which is by far the best-selling guide series about imaginary worlds, and largely outgrows any series of encyclopedia of the real world in terms of revenue.

6.3. Limitations of the "superstimulus" hypothesis

Further research should investigate if this stimulus intensification has limits: Not enough world data could be disappointing or even boring, but, conversely, too much world data could be bewildering, frustrating, or too complex, exactly like the attraction to novelty (Andersen et al., 2020; Clark, 2018; Kidd, Piantadosi, & Aslin, 2012; Kiverstein, Miller, & Rietveld, 2019). This limitation has been mentioned in other studies about stimuli intensification in fictions. For instance, Gessey-Jones et al. (2021) studied the network of character interactions in George R. R. Martin's epic novels, *A Song of Ice and Fire* and found that the degrees of the most connected characters reflect a cognitive limit on the number of concurrent social connections that humans tend to maintain (see also Dunbar, 2017). It is likely that similar limits constrain the size of imaginary worlds.

The example of *No Man's Sky* (2016) is compelling: Through procedural generation of worlds, this video game includes over 18 quintillion planets, with as many different imaginary environments which can be explored with complete autonomy from the players. Before its release, it was expected to be a major hit in the video game industry precisely because it was announced to be the biggest explorable game world (Morris & Hartas, 2004). Yet it has been less successful compared to other exploration-based video games (only 68% of users' evaluations are positive on the popular ranking website for video games *Steam*). Further experimental research could assess whether people are reluctant about virtually infinite imaginary worlds and, if so, why. This is a burning issue for the video game industry because technological improvements make such developments technically feasible, whereas our cognitive constraints might not make them desirable.

7. Discussion

7.1. Remaining questions and alternative explanations

In research fields interested in fictions, there has long been a focus on "who" and "how" questions, about plots and protagonists, at the expense of "where" questions, about settings, probably because of our narrative-oriented understanding of fictions. As Ryan recently wrote, "narrative space remains a relatively unexplored territory" (Ryan, 2014). In this paper, we have provided evidence that narrative spaces, and in particular imaginary worlds, are central in modern fictions partly because they tap into human's preferences for exploration, which have been co-opted by cultural evolution for entertainment. Obviously, more research is needed to further test this theory. For instance, we need to be able to quantify the size of imaginary worlds, that is, the amount of background information associated with a particular world. The existence of clusters of cultural preferences (e.g., imaginary worlds and historical novels) should also be tested rigorously. Besides, several questions remain unsolved: What exactly is the cultural advantage of fictions with imaginary worlds over non-fictions describing the real world (e.g., history books and travel books)? Why are medieval fantasy and space opera so attractive, compared to other imaginary worlds? Is there an ideal cognitive trade-off between too much imagination and too much similarity with the real world? To our knowledge, no empirical research has tested the limits of the processing of novelty in human culture.

On another note, other sets of cognitive mechanisms might play an important role in the appeal for imaginary worlds, and we do not rule out other complementary explanations. For example, systemizing seems central in the appreciation of world-dominant fictions, be it with an imaginary world (e.g., *Star Wars*), or not (e.g., *Sherlock Holmes*). Indeed, although humans are lured by new environments, there is much evidence that they also prefer rich and organized ones (Kaplan, 1987). This might come from our drive to systemize (Baron-Cohen, 2002) and from our cognitive mechanisms which make us intuitively think about plants and animals in highly structured ways (Atran, 1998). This hypothesis is consistent with recent cognitive frameworks stating that curiosity seeks both novelty and complexity to maximize knowledge acquisition (Brändle et al., 2020; Dubey & Griffiths, 2020). This echoes the "encyclopedic impulse" scholars in cultural and literary studies targeted to explain the attractiveness of world-dominant fictions (Besson, 2015; Eco, 1997; Wolf, 2012). It leads to testable predictions about sex differences in cultural preferences for highly structured imaginary worlds.

7.2. Exploratory preferences and other cultural trends

Conversely, our hypothesis could explain other trends in the cultural evolution of fictions. For instance, fanfictions (i.e., fictional writings written by fans and based on previous canonical fictional works) have become highly mainstream in several countries (e.g., *dōjinshi* in Japan and Star Trek fanzine in the United States) and are beginning to be taken very seriously by consumers and the publishing industry. Gamers too started to computationally create more content for their favorite video games, with the intention of sharing it with others. Such alterations of the games are called "mods" (short for "modifications"). More and more game studios create mod tools to ease this process on the fan's side. This massive cultural phenomenon, with fans reshaping and improving video games for the sole benefit of the mod community, and free of charge, has been overlooked in psychological and cognitive research fields (Poor, 2014; Sotamaa, 2010). It has never been put in parallel with literary fan fictions nor with the literature on exploration and curiosity. More generally, the motivation behind unpaid user-generated content (UGC) has mainly been explained with social benefits (Chavez et al., 2020; Crowston & Fagnot, 2018; Daugherty et al., 2008; Omar & Dequan, 2020; Sun et al.,

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

2017) and economic incentives (Poch & Martin, 2015). We argue that our hypothesis could better explain this drive to create new cultural content without any direct return on investment. It relates to the examples we mentioned of several animals that explore even in the presence of other primary rewards, and even with experimentally added costs. Humans seek so much for new information that this may well push fans to create new content, even at some costs. In other words, according to our hypothesis, modders, writers of fan fictions and other participants of UGC, are best seen as curious explorers.

Our hypothesis could also contribute to clarify the cognitive bases of other types of fiction, such as interactive books, films, and TV series (e.g., *Black Mirror: Bandersnatch*, 2018), or, to a lesser extent, crime, mystery, horror, and detective fictions. These genres arguably tap into our exploratory preferences, but not into spatial exploration per se. Rather, they seem to exploit an uncertainty-based form of exploration. We, therefore, believe fictions in these genres target the related mechanisms designed to minimize uncertainty, seek reason-based explanations (Gottlieb et al., 2013; Grodal, 2010; Liquin & Lombrozo, 2020a), and detect and evaluate arguments (Mercier, 2016).

7.3. Imaginary worlds and the cultural evolution of fictionality

Our theory about the cultural evolution imaginary worlds can be put in the wider perspective of the cultural evolution of fiction. We argue that fictionalization has been a gradual process. As it has long been noted by literary historians and literary theorists (Bakhtin & Emerson, 1984; Cave, 1999; Lavocat, 2016; Lévi, 1995; Lu, 1994, 2000; Paige, 2011; Postel, 2019), the most ancient fictions such as The Greek and Indian epics, the Greek and Latin tragedies, and the Arthurian romances, all tend to feature characters (e.g., gods, heroes, and kings) already known to the audience, with plots that are themselves known (e.g., the Trojan War and the story of Tristan and Iseult), and in already familiar worlds (e.g., Troy and the court of King Arthur). As Bakhtin famously wrote: In the epics, "the special interest in the 'end' ('How will the war end?,' 'Who will win?,' 'What will happen to Achilles?,' etc.) is totally excluded." In ancient fictions, creators mostly invent new versions of old stories, with new scenes or secondary characters. The other possibility is that they take the form of anecdotes, legends, *chuanqi* (i.e., "tales of the strange" or "records of the anomalies"), *novella* (i.e., news), which they relate as true, as having really happened to someone they know. It is only gradually that the stories will become fictionalized both by the inclusion of completely new characters and intrigues, and by the progressive abandonment of the claim to veracity.

Thus, we argue that the important question is not whether people in ancient societies "believed" in their fictions (Veyne, 1988) but to which degree their narratives were truly fictional. We argue that in ancient time, such stories were not "as fictional" as they can be in modern societies. This would explain why, for instance, Chinese people recognized fictions not before the Ming and Ch'ing dynasties, only when they "dehistoricized" narratives (Lu, 1994). Consistently, data-driven studies show that it is only in the seventeenth century in England that fiction makers started to write fictions about "nobodies," that is, characters that are completely unknown to the audience (Paige, 2020). It marked the beginning of the "novel" (Bakhtin & Emerson, 1984; Cave, 1999; Lu, 1994; Paige, 2011). In this perspective, imaginary worlds can be thought as the ultimate step of this fictionalization process that started centuries ago: After having fictionalized the events and the protagonists, fiction makers started to fictionalize the settings, giving themselves even more freedom to intensify all stimuli in the fictions.

7.4. Broader concluding remarks

We now discuss some broader conclusions our paper brings about. First, our paper adds further support to the cultural attraction theory according to which human culture is influenced by our cognitive biases (Boyer, 2018; Claidière et al., 2014; Claidière & Sperber, 2007; Morin, 2016; Scott-Phillips et al., 2018; Singh, 2021). Culture is neither faithfully nor randomly transmitted, but rather reconstructed in a way shaped by our cognition. The cultural evolution of imaginary worlds is one example of this cultural evolutionary process: A set of cognitive mechanisms which evolved to solve the adaptive trade-off between exploration and exploitation drives the evolution of fictions with imaginary worlds. Following this view, we disentangled two main paths through which imaginary worlds culturally evolved: Imaginary worlds have emerged and changed over the course of history (1) because our exploratory preferences evolved to adapt to crucial ecological changes, through phenotypic plasticity (sect. 5), and (2) because producers of fictions target and exaggerate already preferred stimuli (sect. 6). Crucially, the combination of these two processes explains both the universality and the cultural variability of imaginary worlds.

Second, we expect that our findings could be relevant for literary theory, cultural history, and fiction study. For instance, the existence of distinct genres such as horror, comedy, and detective fictions has been said to derive from the involvement of distinct sets of cognitive mechanisms (Clasen, 2010; Clasen et al., 2018; Clasen & Platts, 2019; Fishelov, 1995; Grodal, 2010, 2017). Our study extends this on-going research program and could also support the cognitive studies of fictional media, such as cinema (Jullier, 2018; Tan, 2018). We believe our hypothesis, if supported by more empirical evidence, can also be used by scholars in evolutionary psychology and computational history. The consumption of fictions with imaginary worlds could be used as a behavioral proxy to measure the evolution of exploratory preferences, offering insights into their adaptive flexibility to the changing environments.

Finally, it is our belief that this paper could be relevant outside the research domain, for education and fiction production. The fact that children are intrinsically captivated by imaginary worlds suggests that such fictions should be brought into the classrooms. The links between curiosity and learning being increasingly understood (Gordon et al., 2015; Wade & Kidd, 2019), cultural attraction theory could be a relevant and useful framework to design curiosity-based learning interventions. More generally, exploring which types of fictions exploit which cognitive mechanisms brings about new predictions about the socio-psychological determinants of the attractiveness of specific cultural items. Further research in this domain could lead to more fine-grained and evidence-based individual suggestions of which fictions to read or watch. This would have direct implications for the fiction industry and their recommendation algorithms (Nave et al., 2020).

Acknowledgment. The authors thank Sacha Altay, Mélusine Boon-Falleur, Valerian Chambon, Charles de Dampierre, Léo Fitouchi, Hugo Mercier, Olivier Morin, and Valentin Thouzeau.

Financial support. This work was supported by FrontCog funding (ANR-17-EURE-0017).

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Conflict of interest. None.

References

Akchelov, E., & Galanina, E. (2016). Virtual World of Video Games. 2016 8th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES), 1–4. https://doi.org/10.1109/VS-GAMES.2016.7590379.

Alberti, J. (2013). "I Love You, Man": Bromances, the construction of masculinity, and the continuing evolution of the romantic comedy. *Quarterly Review of Film and Video*, *30* (2), 159–172. https://doi.org/10.1080/10509208.2011.575658.

Alves, I., Arenas, M., Currat, M., Sramkova Hanulova, A., Sousa, V. C., Ray, N., & Excoffier, L. (2016). Long-distance dispersal shaped patterns of human genetic diversity in Eurasia. *Molecular Biology and Evolution*, *33*(4), 946–958. https://doi.org/10.1093/molbev/msv332.

Andersen, M. M., Schjoedt, U., Price, H., Rosas, F. E., Scrivner, C., & Clasen, M. (2020). Playing with fear: A field study in recreational horror. *Psychological Science*, *31*(12), 1497–1510. https://doi.org/10.1177/0956797620972116.

André, J.-B., & Baumard, N. (2020). Cultural evolution by capital accumulation. *Evolutionary Human Sciences*, *2*, e18. https://doi.org/10.1017/ehs.2020.19.

André, J.-B., Baumard, N., & Boyer, P. (2020). *The Mystery of Symbolic Culture: What fitness costs? What fitness benefits*? 18. https://osf.io/kdh7t/download?format=pdf.

Atran, S. (1998). Folk biology and the anthropology of science: Cognitive universals and cultural particulars. *Behavioral and Brain Sciences*, *21*(4), 547–569. https://doi.org/10.1017/S0140525X98001277.

Bakhtin, M. M., & Emerson, C. (1984). *Problems of Dostoevsky's poetics*. University of Minnesota Press.

Balling, J. D., & Falk, J. H. (1982). Development of visual preference for natural environments. *Environment and Behavior*, *14*(1), 5–28. https://doi.org/10.1177/0013916582141001.

Baron-Cohen, S. (2002). The extreme male brain theory of autism. *Trends in Cognitive Sciences*, *6*(6), 248–254. https://doi.org/10.1016/S1364-6613(02)01904-6.

Bartle, R. A. (2004). *Designing virtual worlds*. New Riders Pub.

Baumann, O., Dames, P., Kühnel, D., & Walz, B. (2002). Distribution of serotonergic and dopaminergic nerve fibers in the salivary gland complex of the cockroach *Periplaneta americana*. *BMC Physiology*, *15*, 9.

Baumard, N. (2017). Phenotypic plasticity. What scientific term or concept ought to be more widely known? https://www.edge.org/response-detail/27196.

Baumard, N. (2019). Psychological origins of the industrial revolution. *Behavioral and Brain Sciences*, *42*, e189. https://doi.org/10.1017/S0140525X1800211X.

Baumard, N., Huillery, E., & Zabro, L. (in press). The cultural evolution of love in history. *Nature Human Behaviour*.

Behrens, T. E. J., Muller, T. H., Whittington, J. C. R., Mark, S., Baram, A. B., Stachenfeld, K. L., & Kurth-Nelson, Z. (2018). What is a cognitive map? Organizing knowledge for flexible behavior. *Neuron*, *100*(2), 490–509. https://doi.org/10.1016/j.neuron.2018.10.002.

Belsky, J., Goode, M. K., & Most, R. K. (1980). Maternal stimulation and infant exploratory competence: Cross-sectional, correlational, and experimental analyses. *Child Development*, *51*(4), 1168. https://doi.org/10.2307/1129558.

Benson-Amram, S., & Holekamp, K. E. (2012). Innovative problem solving by wild spotted hyenas. *Proceedings of the Royal Society B: Biological Sciences*, *279*(1744), 4087–4095. https://doi.org/10.1098/rspb.2012.1450.

Berger, A. I. (1977). Science-fiction fans in socio-economic perspective: Factors in the social consciousness of a genre. *Science Fiction Studies*, *4*(3), 232–246.

Berlyne, D. E. (1950). Novelty and curiosity as determinants of exploratory behaviour. *British Journal of Psychology. General Section*, *41*(1–2), 68–80. https://doi.org/10.1111/j.2044-8295.1950.tb00262.x.

Berlyne, D. E. (1970). Novelty, complexity, and hedonic value. *Perception & Psychophysics*, *8*(5), 279–286. https://doi.org/10.3758/BF03212593.

Besson, A. (2015). *Constellations: Des mondes fictionnels dans l'imaginaire contemporain*. CNRS éditions.

Besson, A. (2021). *Les pouvoirs de l'enchantement: Usages politiques de la fantasy et de la science-fiction*. Vendémiaire.

Blanchard, T. C., & Gershman, S. J. (2018). Pure correlates of exploration and exploitation in the human brain. *Cognitive, Affective & Behavioral Neuroscience*, *18*(1), 117–126. https://doi.org/10.3758/s13415-017-0556-2.

Blanco, N. J., & Sloutsky, V. M. (2019). Adaptive flexibility in category learning? Young children exhibit smaller costs of selective attention than adults. *Developmental Psychology*, *55*(10), 2060–2076. https://doi.org/10.1037/dev0000777.

Blanco, N. J., & Sloutsky, V. M. (2020). Attentional mechanisms drive systematic exploration in young children. *Cognition*, *202*, 104327. https://doi.org/10.1016/j.cognition.2020.104327.

Blanco, N. J., & Sloutsky, V. M. (2021). Systematic exploration and uncertainty dominate young children's choices. *Developmental Science*, *24*(2), e13026. https://doi.org/10.1111/desc.13026.

Block, A. B., & Wilson, L. A. (Eds.). (2010). *George Lucas's blockbusting: A decade-by-decade survey of timeless movies, including untold secrets of their financial and cultural success* (1st ed). itBooks.

Bloom, P. (2010). *How pleasure works: The new science of why we like what we like* (1st ed). W. W. Norton.

Bogin, B. (1997). Evolutionary hypotheses for human childhood. *Yearbook of Physical Anthropology*, *40*, 27.

Bolt, J., & van Zanden, J. L. (2020). Maddison style estimates of the evolution of the world economy. A new 2020 update. https://www.rug.nl/ggdc/historicaldevelopment/maddison/releases/maddison-project-database-2020?lang=en

Bonawitz, E. B., van Schijndel, T. J. P., Friel, D., & Schulz, L. (2012). Children balance theories and evidence in exploration, explanation, and learning. *Cognitive Psychology*, *64*(4), 215–234. https://doi.org/10.1016/j.cogpsych.2011.12.002.

Boon-Falleur, M., Baumard, N., & André, J.-B. (2020). Risk-seeking or impatient? Disentangling variance and time in hazardous behaviors. *Evolution and Human Behavior*, *42*(5), 453–460. https://doi.org/10.31234/osf.io/phtm8.

Borel, A., Ajzenherc, Y., Moncel, M.-H., Saint Jalme, M., & Krief, S. (2016). Do orangutans share early human interest in odd objects? *Current Anthropology*, *57*(6), 828–837. https://doi.org/10.1086/688855.

Bourdieu, P. (2010). *Outline of a theory of practice* (25. printing). Cambridge Univ. Press.

Bown, N. J., Read, D., & Summers, B. (2003). The lure of choice. *Journal of Behavioral Decision Making*, *16*(4), 297–308. https://doi.org/10.1002/bdm.447.

Boyd, B. (2018). The evolution of stories: From mimesis to language, from fact to fiction. *Wiley Interdisciplinary Reviews: Cognitive Science*, *9*(1), e1444. https://doi.org/10.1002/wcs.1444.

Boyer, P. (2001). *Religion explained: The evolutionary origins of religious thought*. Basic Books.

Boyer, P. (2018). *Minds make societies: How cognition explains the world humans create*. Yale University Press.

Brändle, F., Wu, C. M., & Schulz, E. (2020). What are we curious about? *Trends in Cognitive Sciences*, *24*(9), 685–687. https://doi.org/10.1016/j.tics.2020.05.010.

Broglio, C., Rodríguez, F., & Salas, C. (2003). Spatial cognition and its neural basis in teleost fishes. *Fish and Fisheries*, *4*(3), 247–255. https://doi.org/10.1046/j.1467-2979.2003.00128.x.

Bromberg-Martin, E. S., Matsumoto, M., & Hikosaka, O. (2010). Dopamine in motivational control: Rewarding, aversive, and alerting. *Neuron*, *68*(5), 815–834. https://doi.org/10.1016/j.neuron.2010.11.022.

Buchsbaum, D., Bridgers, S., Skolnick Weisberg, D., & Gopnik, A. (2012). The power of possibility: Causal learning, counterfactual reasoning, and pretend play. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1599), 2202–2212. https://doi.org/10.1098/rstb.2012.0122.

Bunzeck, N., & Düzel, E. (2006). Absolute coding of stimulus novelty in the human substantia nigra/VTA. *Neuron*, *51*(3), 369–379. https://doi.org/10.1016/j.neuron.2006.06.021.

Buss, D. M. (2015). *Evolutionary psychology: The new science of the mind* (Fifth edn). Pearson.

Butler, J. C. (2000). Personality and emotional correlates of right-wing authoritarianism. *Social Behavior and Personality: An International Journal*, *28*(1), 1–14. https://doi.org/10.2224/sbp.2000.28.1.1.

Byrne, R. W. (2013). Animal curiosity. *Current Biology*, *23*(11), R469–R470. https://doi.org/10.1016/j.cub.2013.02.058.

Canet, F. (2016). Quantitative approaches for evaluating the influence of films using the IMDb database. *Communication & Society*, *29*(2), 151–172. https://doi.org/10.15581/003.29.2.151-172.

Carbone, E., Meneghetti, C., & Borella, E. (2019). The influence of personality traits and facets on visuo-spatial task performance and self-assessed visuo-spatial inclinations in young and older adults. *PLoS ONE*, *14*(8), e0220525. https://doi.org/10.1371/journal.pone.0220525.

Carbone, E., Meneghetti, C., & Borella, E. (2020). The role of personality in route learning in young and older adults. *Personality and Individual Differences*, *166*, 110187. https://doi.org/10.1016/j.paid.2020.110187.

Carroll, J. (2012). *Literary Darwinism: Evolution, human nature, and literature*. Routledge. https://www.taylorfrancis.com/books/e/9780203505274.

Carter, G. G., Forss, S., Page, R. A., & Ratcliffe, J. M. (2018). Younger vampire bats (*Desmodus rotundus*) are more likely than adults to explore novel objects. *PLoS ONE*, *13*(5), e0196889. https://doi.org/10.1371/journal.pone.0196889.

Cashdan, E., & Gaulin, S. J. C. (2016). Why go there? Evolution of mobility and spatial cognition in women and men: An introduction to the special issue. *Human Nature*, *27* (1), 1–15. https://doi.org/10.1007/s12110-015-9253-4.

Catania, A. C. (1980). Freedom of choice: A behavioral analysis. In *Psychology of learning and motivation* (Vol. 14, pp. 97–145). Elsevier. https://doi.org/10.1016/S0079-7421(08)60160-7.

Catania, A. C., & Sagvolden, T. (1980). Preference for free choice over forced choice in pigeons. *Journal of the Experimental Analysis of Behavior*, *34*(1), 77–86. https://doi.org/10.1901/jeab.1980.34-77.

Cave, T. (1999). *Pré-histoires: Textes troublés au seuil de la modernité*. Libr. Droz.

Chakroun, K., Mathar, D., Wiehler, A., Ganzer, F., & Peters, J. (2020). Dopaminergic modulation of the exploration/exploitation trade-off in human decision-making. *eLife*, *9*, e51260. https://doi.org/10.7554/eLife.51260.

Chambon, V., Thero, H., Findling, C., & Koechlin, E. (2018). *Believing in one's power: A counterfactual heuristic for goal-directed control* (Preprint). *Neuroscience*. https://doi.org/10.1101/498675.

Chapman, B. B., Hulthén, K., Wellenreuther, M., Hansson, L.-A., Nilsson, J.-Å., & Brönmark, C. (2014). Patterns of animal migration. In L.-A. Hansson & S. Åkesson (Eds.), *Animal movement across scales* (pp. 11–35). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199677184.003.0002.

Charnov, E. L. (1976). Optimal foraging, the marginal value theorem. *Theoretical Population Biology*, *9*(2), 129–136. https://doi.org/10.1016/0040-5809(76)90040-X.

Chau, A. (2018). From Nobel to Hugo: Reading Chinese science fiction as world literature. *Modern Chinese Literatre and Culture*, *30*(1), 27.

Chavez, L., Ruiz, C., Curras, R., & Hernandez, B. (2020). The role of travel motivations and social media use in consumer interactive behaviour: A uses and gratifications perspective. *Sustainability*, *12*(21), 8789. https://doi.org/10.3390/su12218789.

Claidière, N., Scott-Phillips, T. C., & Sperber, D. (2014). How Darwinian is cultural evolution? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *369* (1642), 20130368. https://doi.org/10.1098/rstb.2013.0368.

Claidière, N., & Sperber, D. (2007). The role of attraction in cultural evolution. *Journal of Cognition and Culture*, *7*(1–2), 89–111. https://doi.org/10.1163/156853707X171829.

Clark, A. (2018). A nice surprise? Predictive processing and the active pursuit of novelty. *Phenomenology and the Cognitive Sciences*, *17*(3), 521–534. https://doi.org/10.1007/s11097-017-9525-z.

Clasen, M. (2010). The horror! The horror!. *The Evolutionary Review*, *1*, 112–119.

Clasen, M., Kjeldgaard-Christiansen, J., & Johnson, J. A. (2018). Horror, personality, and threat simulation: A survey on the psychology of scary media. *Evolutionary Behavioral Sciences*, *14*(3), 213–230. https://doi.org/10.1037/ebs0000152.

Clasen, M., & Platts, T. K. (2019). Evolution and slasher films. In D. Vanderbeke & B. Cooke (Eds.), *Evolution and popular narrative* (pp. 23–42). Brill Rodopi. https://doi.org/10.1163/9789004391161_003.

Clay, D. (2007). The islands of the odyssey. *Journal of Medieval and Early Modern Studies*, *37*(1), 141–161. https://doi.org/10.1215/10829636-2006-013.

Cohen, J. D., McClure, S. M., & Yu, A. J. (2007). Should I stay or should I go? How the human brain manages the trade-off between exploitation and exploration. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*(1481), 933–942. https://doi.org/10.1098/rstb.2007.2098.

Costa, V. D., Mitz, A. R., & Averbeck, B. B. (2019). Subcortical substrates of explore-exploit decisions in primates. *Neuron*, *103*(3), 533–545, e5. https://doi.org/10.1016/j.neuron.2019.05.017.

Costa, V. D., Tran, V. L., Turchi, J., & Averbeck, B. B. (2014). Dopamine modulates novelty seeking behavior during decision making. *Behavioral Neuroscience*, *128*(5), 556–566. https://doi.org/10.1037/a0037128.

Cox, A., & Fisher, M. (2009). The Texas billionaire's pregnant bride: An evolutionary interpretation of romance fiction titles. Journal of Social, *Evolutionary, and Cultural Psychology*, *3*(4), 386–401. https://doi.org/10.1037/h0099308.

Crowston, K., & Fagnot, I. (2018). Stages of motivation for contributing user-generated content: A theory and empirical test. *International Journal of Human-Computer Studies*, *109*, 89–101. https://doi.org/10.1016/j.ijhcs.2017.08.005.

Cutting, J. E., Brunick, K. L., DeLong, J. E., Iricinschi, C., & Candan, A. (2011). Quicker, faster, darker: Changes in Hollywood film over 75 years. *I-Perception*, *2*(6), 569–576. https://doi.org/10.1068/i0441aap.

Damerius, L. A., Graber, S. M., Willems, E. P., & van Schaik, C. P. (2017). Curiosity boosts orangutan problem-solving ability. *Animal Behaviour*, *134*, 57–70. https://doi.org/10.1016/j.anbehav.2017.10.005.

Daugherty, T., Eastin, M. S., & Bright, L. (2008). Exploring consumer motivations for creating user-generated content. *Journal of Interactive Advertising*, *8*(2), 16–25. https://doi.org/10.1080/15252019.2008.10722139.

Daw, N. D., O'Doherty, J. P., Dayan, P., Seymour, B., & Dolan, R. J. (2006). Cortical substrates for exploratory decisions in humans. *Nature*, *441*(7095), 876–879. https://doi.org/10.1038/nature04766.

de Courson, B., & Baumard, N. (2019). *Quantifying the scientific revolution* (preprint). *SocArXiv*. https://doi.org/10.31235/osf.io/9ex8q.

Defeyter, M. A., & German, T. P. (2003). Acquiring an understanding of design: Evidence from children's insight problem solving. *Cognition*, *89*(2), 133–155. https://doi.org/10.1016/S0010-0277(03)00098-2.

Del Giudice, M. (2014). Middle childhood: An evolutionary-developmental synthesis. *Child Development Perspectives*, *8*(4), 193–200. https://doi.org/10.1111/cdep.12084.

Delle, S. (2015). The power of imagination and the fan creation of muggle quidditch. In L. S. Brenner (Ed.), *Playing harry potter: Essays and interviews on fandom and performance* (pp. 75–85). McFarland & Company, Inc., Publishers.

DeYoung, C. G. (2013). The neuromodulator of exploration: A unifying theory of the role of dopamine in personality. *Frontiers in Human Neuroscience*, *7*. https://doi.org/10.3389/fnhum.2013.00762.

DeYoung, C. G. (2015). Openness/intellect: A dimension of personality reflecting cognitive exploration. In M. Mikulincer, P. R. Shaver, M. L. Cooper & R. J. Larsen (Eds.), *APA Handbook of personality and social psychology, volume* 4: *Personality processes and individual differences*. (pp. 369–399). American Psychological Association. https://doi.org/10.1037/14343-017.

Dubey, R., & Griffiths, T. L. (2020). Reconciling novelty and complexity through a rational analysis of curiosity. *Psychological Review*, *127*(3), 455–476. https://doi.org/10.1037/rev0000175.

Dubourg, E., & Baumard, N. (in press). Why and how did narrative fictions evolve? Fictions as entertainment technology. *Frontiers in Psychology*.

Dubourg, E., Thouzeau, V., de Dampierre, C., & Baumard, N. (2021). Exploratory preferences explain the cultural success of imaginary worlds in modern societies. *PsyArXiv*. https://doi.org/10.31234/osf.io/d9uqs.

Dunbar, R. (2017). Cognitive and network constraints in real life and literature. In R. Kenna, M. MacCarron & P. MacCarron (Eds.), *Maths meets myths: Quantitative approaches to ancient narratives* (pp. 7–19). Springer International Publishing. https://doi.org/10.1007/978-3-319-39445-9_2.

Düzel, E., Bunzeck, N., Guitart-Masip, M., & Düzel, S. (2010). Novelty-related motivation of anticipation and exploration by dopamine (NOMAD): Implications for healthy aging. *Neuroscience & Biobehavioral Reviews*, *34*(5), 660–669. https://doi.org/10.1016/j.neubiorev.2009.08.006.

Eco, U. (1997). *The role of the reader: Explorations in the semiotics of texts* (First Midland Book ed. 1984 [Nachdr.]). Indiana Univ. Pr.

Ekman, S. (2013). *Here be dragons: Exploring fantasy maps and settings*. Wesleyan University Press.

Eliassen, S., Jørgensen, C., Mangel, M., & Giske, J. (2007). Exploration or exploitation: Life expectancy changes the value of learning in foraging strategies. *Oikos*, *116*(3), 513–523. https://doi.org/10.1111/j.2006.0030-1299.15462.x.

Elza, C. (2014). Alice in Cartoonland: Childhood, gender, and imaginary space in early Disney animation. *Animation*, *9*(1), 7–26. https://doi.org/10.1177/1746847714520936.

Englerova, K., Klement, D., Frynta, D., Rokyta, R., & Nekovarova, T. (2019). Reactions to novel objects in monkeys: What does it mean to be neophobic? *Primates*, *60*(4), 347–353. https://doi.org/10.1007/s10329-019-00731-2.

English, S., Fawcett, T. W., Higginson, A. D., Trimmer, P. C., & Uller, T. (2016). Adaptive use of information during growth can explain long-term effects of early life experiences. *The American Naturalist*, *187*(5), 620–632. https://doi.org/10.1086/685644.

Epstein, R. A., Patai, E. Z., Julian, J. B., & Spiers, H. J. (2017). The cognitive map in humans: Spatial navigation and beyond. *Nature Neuroscience*, *20*(11), 10.

Etchells, P. (2019). *Lost in a good game: Why we play video games and what they can do for us*. Icon Books Ltd.

Fagan, J. F. (1970). Memory in the infant. *Journal of Experimental Child Psychology*, *9*(2), 217–226. https://doi.org/10.1016/0022-0965(70)90087-1.

Falk, J. H., & Balling, J. D. (2010). Evolutionary influence on human landscape preference. *Environment and Behavior*, *42*(4), 479–493. https://doi.org/10.1177/0013916509341244.

Ferrara, E., Banerjee, A., & Orozco, V. (2019). MTV Shuga: Changing social norms and behaviors with entertainment education in Nigeria. Working Paper. https://www.povertyactionlab.org/publication/entertaining-way-behavioral-change-fighting-hiv-mtv.

Fishelov, D. (1995). The structure of generic categories: Some cognitive aspects. *Journal of Literary Semantics*, *24*(2), 117–126. https://doi.org/10.1515/jlse.1995.24.2.117.

FitzGibbon, L., Lau, J. K. L., & Murayama, K. (2020). The seductive lure of curiosity: Information as a motivationally salient reward. *Current Opinion in Behavioral Sciences*, *35*, 21–27. https://doi.org/10.1016/j.cobeha.2020.05.014.

Flinn, M. V., & Ward, C. V. (2005). Ontogeny and evolution of the social child. In B. J. Ellis & D. F. Bjorklund (Eds.), *Origins of the social mind: Evolutionary psychology and child development* (pp. 19–44). Guilford Press.

Frank, M. J., Doll, B. B., Oas-Terpstra, J., & Moreno, F. (2009). Prefrontal and striatal dopaminergic genes predict individual differences in exploration and exploitation. *Nature Neuroscience*, *12*(8), 1062–1068. https://doi.org/10.1038/nn.2342.

Frankenhuis, W. E., & Nettle, D. (2020). Integration of plasticity research across disciplines. *Current Opinion in Behavioral Sciences*, *36*, 157–162. https://doi.org/10.1016/j.cobeha.2020.10.012.

Frankenhuis, W. E., Panchanathan, K., & Nettle, D. (2016). Cognition in harsh and unpredictable environments. *Current Opinion in Psychology*, *7*, 76–80. https://doi.org/10.1016/j.copsyc.2015.08.011.

Genette, G. (1997). *Paratexts: Thresholds of interpretation*. Cambridge University Press.

George, J. M., & Zhou, J. (2001). When openness to experience and conscientiousness are related to creative behavior: An interactional approach. *Journal of Applied Psychology*, *86*(3), 513–524. https://doi.org/10.1037/0021-9010.86.3.513.

Gershman, S. J. (2018). Deconstructing the human algorithms for exploration. *Cognition*, *173*, 34–42. https://doi.org/10.1016/j.cognition.2017.12.014.

Gessey-Jones, T., Connaughton, C., Dunbar, R., Kenna, R., MacCarron, P., O'Conchobhair, C., & Yose, J. (2020). Narrative structure of *A Song of Ice and Fire* creates a fictional world with realistic measures of social complexity. *Proceedings of the National Academy of Sciences*, *117*(46), 28582–28588. https://doi.org/10.1073/pnas.2006465117.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Gocłowska, M. A., Ritter, S. M., Elliot, A. J., & Baas, M. (2019). Novelty seeking is linked to openness and extraversion, and can lead to greater creative performance. *Journal of Personality*, *87*(2), 252–266. https://doi.org/10.1111/jopy.12387.

Goody, J. (1986). *The logic of writing and the organization of society* (1st ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511621598.

Gopnik, A. (2020). Childhood as a solution to explore–exploit tensions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1803), 20190502. https://doi.org/10.1098/rstb.2019.0502.

Gopnik, A., Griffiths, T. L., & Lucas, C. G. (2015). When younger learners can be better (or at least more open-minded) than older ones. *Current Directions in Psychological Science*, *24*(2), 87–92. https://doi.org/10.1177/0963721414556653.

Gopnik, A., O'Grady, S., Lucas, C. G., Griffiths, T. L., Wente, A., Bridgers, S., … Dahl, R. E. (2017). Changes in cognitive flexibility and hypothesis search across human life history from childhood to adolescence to adulthood. *Proceedings of the National Academy of Sciences*, *114*(30), 7892–7899. https://doi.org/10.1073/pnas.1700811114.

Gordon, G., Breazeal, C., & Engel, S. (2015). Can children catch curiosity from a social robot? *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction – HRI*, *15*, 91–98. https://doi.org/10.1145/2696454.2696469.

Gottlieb, J., & Oudeyer, P.-Y. (2018). Towards a neuroscience of active sampling and curiosity. *Nature Reviews Neuroscience*, *19*(12), 758–770. https://doi.org/10.1038/s41583-018-0078-0.

Gottlieb, J., Oudeyer, P.-Y., Lopes, M., & Baranes, A. (2013). Information-seeking, curiosity, and attention: Computational and neural mechanisms. *Trends in Cognitive Sciences*, *17*(11), 585–593. https://doi.org/10.1016/j.tics.2013.09.001.

Gottschall, J. (2012). *The storytelling animal: How stories make us human*. Houghton Mifflin Harcourt.

Gottschall, J. & Wilson, D. S. (Eds.) (2005). *The literary animal: Evolution and the nature of narrative*. Northwestern University Press.

Gould, S. J. (2008). A biological homage to mickey mouse. *Ecotone*, *4*(1–2), 333–340. https://doi.org/10.1353/ect.2008.0045.

Gozli, D. G. (2018). Reaching into the unknown: Actions, goal hierarchies, and explorative agency. *Frontiers in Psychology*, *9*, 6.

Grodal, T. (2010). High on crime fiction and detection. *Projections*, *4*(2), 64–85. https://doi.org/10.3167/proj.2010.040205.

Grodal, T. (2017). How film genres are a product of biology, evolution and culture – An embodied approach. *Palgrave Communications*, *3*(1), 17079. https://doi.org/10.1057/palcomms.2017.79.

Guarino, S., Yeater, D., Lacy, S., Dees, T., & Hill, H. M. (2017). Responses to familiar and unfamiliar objects by belugas (*Delphinapterus leucas*), bottlenose dolphins (*Tursiops truncatus*), and Pacific white-sided dolphins (*Lagenorhynchus obliquidens*). *Animal Cognition*, *20*(5), 823–827. https://doi.org/10.1007/s10071-017-1103-9.

Gunderson, V. M., & Sackett, G. P. (1984). Development of pattern recognition in infant pigtailed macaques (*Macaca nemestrina*). *Developmental Psychology*, *20*(3), 418–426. https://doi.org/10.1037/0012-1649.20.3.418.

Haggard, P., & Chambon, V. (2012). Sense of agency. *Current Biology*, *22*(10), R390–R392. https://doi.org/10.1016/j.cub.2012.02.040.

Hakimi, S., Hejazi, E., & Lavasani, M. G. (2011). The relationships between personality traits and students' academic achievement. *Procedia – Social and Behavioral Sciences*, *29*, 836–845. https://doi.org/10.1016/j.sbspro.2011.11.312.

Hayden, B. Y., & Niv, Y. (2021). The case against economic values in the orbitofrontal cortex (or anywhere else in the brain). *Behavioral Neuroscience*, *135*(2), 192–201. https://doi.org/10.1037/bne0000448.

Healy, S., Dekort, S., & Clayton, N. (2005). The hippocampus, spatial memory and food hoarding: A puzzle revisited. *Trends in Ecology & Evolution*, *20*(1), 17–22. https://doi.org/10.1016/j.tree.2004.10.006.

Herzog, T. R. (1984). A cognitive analysis of preference for field-and-forest environments. *Landscape Research*, *9*(1), 10–16. https://doi.org/10.1080/01426398408706092.

Herzog, T. R. (1985). A cognitive analysis of preference for waterscapes. *Journal of Environmental Psychology*, *5*(3), 225–241. https://doi.org/10.1016/S0272-4944(85)80024-4.

Herzog, T. R., & Bryce, A. G. (2007). Mystery and preference in within-forest settings. *Environment and Behavior*, *39*(6), 779–796. https://doi.org/10.1177/0013916506298796.

Herzog, T., & Smith, G. A. (1988). Danger, mystery, and environmental preference. *Environment and Behavior*, *20*(3), 320–344. https://doi.org/10.1177/0013916588203004.

Hewlett, B., van de Koppel, J. M. H., & Cavalli-Sforza, L. L. (1982). Exploration ranges of Aka pygmies of the Central African Republic. *Man*, *17*(3), 418. https://doi.org/10.2307/2801706.

Hills, T. (2004). Dopamine and glutamate control area-restricted search behavior in *Caenorhabditis elegans*. *Journal of Neuroscience*, *24*(5), 1217–1225. https://doi.org/10.1523/JNEUROSCI.1569-03.2004.

Hills, T. T. (2006). Animal foraging and the evolution of goal-directed cognition. *Cognitive Science*, *30*(1), 3–41. https://doi.org/10.1207/s15516709cog0000_50.

Hills, T. T., & Stroup, W. (2004). *Cognitive exploration and search behavior in the development of endogenous representations*. San Diego: American Educational Research Association.

Hills, T. T., Todd, P. M., & Goldstone, R. L. (2010). The central executive as a search process: Priming exploration and exploitation across domains. *Journal of Experimental Psychology: General*, *139*(4), 590–609. https://doi.org/10.1037/a0020666.

Hills, T. T., Todd, P. M., Lazer, D., Redish, A. D., & Couzin, I. D. (2015). Exploration versus exploitation in space, mind, and society. *Trends in Cognitive Sciences*, *19*(1), 46–54. https://doi.org/10.1016/j.tics.2014.10.004.

Hinde, R. A., & Barden, L. A. (1985). The evolution of the teddy bear. *Animal Behaviour*, *33*(4), 1371–1373. https://doi.org/10.1016/S0003-3472(85)80205-0.

Horvitz, J. C., Stewart, T., & Jacobs, B. L. (1997). Burst activity of ventral tegmental dopamine neurons is elicited by sensory stimuli in the awake cat. *Brain Research*, *759*(2), 251–258. https://doi.org/10.1016/S0006-8993(97)00265-5.

Hughes, R. N. (2007). Neotic preferences in laboratory rodents: Issues, assessment and substrates. *Neuroscience & Biobehavioral Reviews*, *31*(3), 441–464. https://doi.org/10.1016/j.neubiorev.2006.11.004.

Humphreys, K. L., Lee, S. S., Telzer, E. H., Gabard-Durnam, L. J., Goff, B., Flannery, J., & Tottenham, N. (2015). Exploration–exploitation strategy is dependent on early experience: Exploration–exploitation. *Developmental Psychobiology*, *57*(3), 313–321. https://doi.org/10.1002/dev.21293.

Ikemi, M. (2005). The effects of mystery on preference for residential façades. *Journal of Environmental Psychology*, *25*(2), 167–173. https://doi.org/10.1016/j.jenvp.2005.04.001.

Inglehart, R. (2018). *Cultural evolution: People's motivations are changing, and reshaping the world* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781108613880.

Jacobs, L. F. (2003). The evolution of the cognitive map. *Brain, Behavior and Evolution*, *62*(2), 128–139. https://doi.org/10.1159/000072443.

Jacquet, P. O., Safra, L., Wyart, V., Baumard, N., & Chevallier, C. (2019). The ecological roots of human susceptibility to social influence: A pre-registered study investigating the impact of early-life adversity. *Royal Society Open Science*, *6*(1), 180454. https://doi.org/10.1098/rsos.180454.

Jenkins, H. (Ed.) (1998). *The children's culture reader*. New York University Press.

Jenkins, H. (2006). *Convergence culture: Where old and new media collide*. New York University Press.

Jiang, Q. (2013). Translation and the development of science fiction in twentieth-century China. *Science-Fiction Studies*, *40*(1), 116–132. https://doi.org/10.5621/sciefictstud.40.1.0116.

Jobling, I. (2001). The psychological foundations of the hero-ogre story: A cross-cultural study. *Human Nature*, *12*(3), 247–272. https://doi.org/10.1007/s12110-001-1009-7.

Jourde, P. (1991). *Géographies imaginaires de quelques inventeurs de mondes au XXe siècle: Gracq, borges, michaux*, Tolkien. J. Corti.

Jullier, L. (2018). Cinéma et psychologie cognitive: Le "tournant corporel" des études audiovisuelles. *Ekphrasis. Images, Cinema, Theory, Media*, *20*(2), 20–34. https://doi.org/10.24193/ekphrasis.20.2.

Kakade, S., & Dayan, P. (2002). Dopamine: Generalization and bonuses. *Neural Networks*, *15*(4–6), 549–559. https://doi.org/10.1016/S0893-6080(02)00048-5.

Kaplan, H., & Gangestad, S. W. (2015). Life history theory and evolutionary psychology. In D. M. Buss (Ed.), *The handbook of evolutionary psychology* (2nd ed., pp. 88–114). Wiley. https://doi.org/10.1002/9781119125563.evpsych102.

Kaplan, H., Hill, K., Lancaster, J., & Hurtado, A. M. (2000). A theory of human life history evolution: Diet, intelligence, and longevity. *Evolutionary Anthropology*, *9*(4), 156–185.

Kaplan, H., & Robson, A. J. (2002). The emergence of humans: The coevolution of intelligence and longevity with intergenerational transfers. *Proceedings of the National Academy of Sciences*, *99*(15), 10221–10226. https://doi.org/10.1073/pnas.152502899.

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. Cambridge University Press.

Kaplan, S. (1987). Aesthetics, affect, and cognition: Environmental preference from an evolutionary perspective. *Environment and Behavior*, *19*(1), 3–32. https://doi.org/10.1177/0013916587191001.

Kaplan, S. (1988). Perception and landscape: Conceptions and misconceptions. In J. L. Nasar (Ed.), *Environmental aesthetics* (1st ed., pp. 45–55). Cambridge University Press. https://doi.org/10.1017/CBO9780511571213.006.

Katz, K., & Naug, D. (2015). Energetic state regulates the exploration–exploitation trade-off in honeybees. *Behavioral Ecology*, *26*(4), 1045–1050. https://doi.org/10.1093/beheco/arv045.

Kidd, C., & Hayden, B. Y. (2015). The psychology and neuroscience of curiosity. *Neuron*, *88*(3), 449–460. https://doi.org/10.1016/j.neuron.2015.09.010.

Kidd, C., Piantadosi, S. T., & Aslin, R. N. (2012). The goldilocks effect: Human infants allocate attention to visual sequences that are neither too simple nor too complex. *PLoS ONE*, *7*(5), e36399. https://doi.org/10.1371/journal.pone.0036399.

Kiverstein, J., Miller, M., & Rietveld, E. (2019). The feeling of grip: Novelty, error dynamics, and the predictive brain. *Synthese*, *196*(7), 2847–2869. https://doi.org/10.1007/s11229-017-1583-9.

Knutson, B., & Cooper, J. C. (2006). The lure of the unknown. *Neuron*, *51*(3), 280–282. https://doi.org/10.1016/j.neuron.2006.07.017.

Konzack, L. (2018). Transmediality. In M. J. P. Wolf (Ed.), *The Routledge companion to imaginary worlds* (pp. 134–140). Routledge.

Korobkova, E., Emonet, T., Vilar, J. M. G., Shimizu, T. S., & Cluzel, P. (2004). From molecular noise to behavioural variability in a single bacterium. *Nature*, *428*(6982), 574–578. https://doi.org/10.1038/nature02404.

Koster, R., Seow, T. X., Dolan, R. J., & Düzel, E. (2016). Stimulus novelty energizes actions in the absence of explicit reward. *PLoS ONE*, *11*(7), e0159120. https://doi.org/10.1371/journal.pone.0159120.

Krebs, R. M., Schott, B. H., Schütze, H., & Düzel, E. (2009). The novelty exploration bonus and its attentional modulation. *Neuropsychologia*, *47*(11), 2272–2281. https://doi.org/10.1016/j.neuropsychologia.2009.01.015.

Krueger, P. M., Wilson, R. C., & Cohen, J. D. (2017). Strategies for exploration in the domain of losses. *Judgment and Decision Making*, *14*, 104–117.

Kuipers, G., & de Kloet, J. (2009). Banal cosmopolitanism and *The Lord of the Rings*: The limited role of national differences in global media consumption. *Poetics*, *37*(2), 99–118. https://doi.org/10.1016/j.poetic.2009.01.002.

Lavocat, F. (2016). *Fait et fiction: Pour une frontière*. Éditions du Seuil.

Le Heron, C., Kolling, N., Plant, O., Kienast, A., Janska, R., Ang, Y.-S., … Apps, M. A. J. (2020). Dopamine modulates dynamic decision-making during foraging. *Journal of Neuroscience*, *40*(27), 5273–5282. https://doi.org/10.1523/JNEUROSCI.2586-19.2020.

Lee, E. S. (1966). A theory of migration. *Demography*, *3*(1), 47–57.

Lévi, J. (1995). *La chine romanesque: Fictions d'Orient et d'Occident*. Seuil.

Li, W., Li, X., Huang, L., Kong, X., Yang, W., Wei, D., … Liu, J. (2015). Brain structure links trait creativity to openness to experience. *Social Cognitive and Affective Neuroscience*, *10*(2), 191–198. https://doi.org/10.1093/scan/nsu041.

Liquin, E. G., & Gopnik, A. (2019). *Learning from approach-avoid decisions: Children explore and learn more than adults*. Paper presented at the Baltimore, MD: Society for Research in Child Development.

Liquin, E. G., & Lombrozo, T. (2020a). A functional approach to explanation-seeking curiosity. *Cognitive Psychology*, *119*, 101276. https://doi.org/10.1016/j.cogpsych.2020.101276.

Liquin, E. G., & Lombrozo, T. (2020b). Explanation-seeking curiosity in childhood. *Current Opinion in Behavioral Sciences*, *35*, 14–20. https://doi.org/10.1016/j.cobeha.2020.05.012.

Louwerse, M. M., & Benesh, N. (2012). Representing spatial structure through maps and language: *Lord of the Rings* encodes the spatial structure of middle earth. *Cognitive Science*, *36*(8), 1556–1569. https://doi.org/10.1111/cogs.12000.

Louwerse, M. M., & Zwaan, R. A. (2009). Language encodes geographical information. *Cognitive Science*, *33*(1), 51–73. https://doi.org/10.1111/j.1551-6709.2008.01003.x.

Lu, H. (1994). *From historicity to fictionality: The Chinese poetics of narrative*. Stanford University Press.

Lu, X. (2000). *A brief history of Chinese fiction*. University press of the Pacific.

Lucas, C. G., Bridgers, S., Griffiths, T. L., & Gopnik, A. (2014). When children are better (or at least more open-minded) learners than adults: Developmental differences in learning the forms of causal relationships. *Cognition*, *131*(2), 284–299. https://doi.org/10.1016/j.cognition.2013.12.010.

Lucian of Samosata. (150 C.E.). *True history*.

MacDonald, D. H., & Hewlett, B. S. (1999). Reproductive interests and forager mobility. *Current Anthropology*, *40*(4), 501–524. https://doi.org/10.1086/200047.

Mar, R. A. (2018). Evaluating whether stories can promote social cognition: Introducing the social processes and content entrained by narrative (SPaCEN) framework. *Discourse Processes*, *55*(5–6), 454–479. https://doi.org/10.1080/0163853X.2018.1448209.

Mar, R. A., & Oatley, K. (2008). The function of fiction is the abstraction and simulation of social experience. *Perspectives on Psychological Science*, *3*(3), 173–192. https://doi.org/10.1111/j.1745-6924.2008.00073.x.

Martins, M. d. J. D., & Baumard, N. (2020). The rise of prosociality in fiction preceded democratic revolutions in early modern Europe. *Proceedings of the National Academy of Sciences*, *117*(46), 28684–28691. https://doi.org/10.1073/pnas.2009571117.

Martins, M. d. J. D., & Baumard, N. (2021). Loving, fast and slow: A quantitative history of passion and tenderness in early modern Europe. Working Paper.

Maspons, J., Molowny-Horas, R., & Sol, D. (2019). Behaviour, life history and persistence in novel environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *374*(1781), 20180056. https://doi.org/10.1098/rstb.2018.0056.

McCrae, R. R. (1993). Openness to experience as a basic dimension of personality. *Imagination, Cognition and Personality*, *13*(1), 39–55. https://doi.org/10.2190/H8H6-QYKR-KEU8-GAQ0.

McDevitt, M. A., Pisklak, J. M., Spetch, M., & Dunn, R. (2018). The influence of outcome delay on suboptimal choice. *Behavioural Processes*, *157*, 279–285. https://doi.org/10.1016/j.beproc.2018.10.008.

Mehlhorn, K., Newell, B. R., Todd, P. M., Lee, M. D., Morgan, K., Braithwaite, V. A., … Gonzalez, C. (2015). Unpacking the exploration–exploitation tradeoff: A synthesis of human and animal literatures. *Decision*, *2*(3), 191–215. https://doi.org/10.1037/dec0000033.

Mell, H., Baumard, N., & André, J.-B. (2021). Time is money. Waiting costs explain why selection favors steeper time discounting in deprived environments. *Evolution and Human Behavior*, *42*(4), 379–387.

Mellmann, K. (2012). Is storytelling a biological adaptation? Preliminary thoughts on how to pose that question. In C. Gansel & D. Vanderbeke (Eds.), *Telling stories/geschichten erzählen* (pp. 30–49). De Gruyter. https://doi.org/10.1515/9783110268683.30.

Menadue, C. B., & Jacups, S. (2018). Who reads science fiction and fantasy, and how do they feel about science? Preliminary findings from an online survey. *SAGE Open*, *8*(2), 215824401878094. https://doi.org/10.1177/2158244018780946.

Meneghetti, C., Grimaldi, F., Nucci, M., & Pazzaglia, F. (2020). Positive and negative way-finding inclinations, choice of navigation aids, and How they relate to personality traits. *Journal of Individual Differences*, *41*(1), 45–52. https://doi.org/10.1027/1614-0001/a000302.

Mercier, H. (2016). The argumentative theory: Predictions and empirical evidence. *Trends in Cognitive Sciences*, *20*(9), 689–700.

Mettke-Hofmann, C., Winkler, H., & Leisler, B. (2002). The significance of ecological factors for exploration and neophobia in parrots. *Ethology*, *108*(3), 249–272. https://doi.org/10.1046/j.1439-0310.2002.00773.x.

Miller, G. (2001). *The mating mind: How sexual choice shaped the evolution of human nature*. Anchor Books.

Miner, E. J., Gurven, M., Kaplan, H., & Gaulin, S. J. C. (2014). Sex difference in travel is concentrated in adolescence and tracks reproductive interests. *Proceedings of the Royal Society B: Biological Sciences*, *281*(1796), 20141476. https://doi.org/10.1098/rspb.2014.1476.

Montello, D. R. (2005). Navigation. In P. Shah & A. Miyake (Eds.), *The Cambridge handbook of visuospatial thinking* (1st ed., pp. 257–294). Cambridge University Press. https://doi.org/10.1017/CBO9780511610448.008.

Morgan, T. J. H., Suchow, J. W., & Griffiths, T. L. (2020). Experimental evolutionary simulations of learning, memory and life history. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1803), 20190504. https://doi.org/10.1098/rstb.2019.0504.

Morin, O. (2016). Reasons to be fussy about cultural evolution. *Biology & Philosophy*, *31*(3), 447–458. https://doi.org/10.1007/s10539-016-9516-4.

Morin, O., Acerbi, A., & Sobchuk, O. (2019). Why people die in novels: Testing the ordeal simulation hypothesis. *Palgrave Communications*, *5*(1), 62. https://doi.org/10.1057/s41599-019-0267-0.

Morris, D., & Hartas, L. (2004). *The art of game worlds*. Ilex.

Muffato, V., Meneghetti, C., & De Beni, R. (2016). Not all is lost in older adults' route learning: The role of visuo-spatial abilities and type of task. *Journal of Environmental Psychology*, *47*, 230–241. https://doi.org/10.1016/j.jenvp.2016.07.003.

Muffato, V., Toffalini, E., Meneghetti, C., Carbone, E., & De Beni, R. (2017). Individual visuo-spatial factors and familiar environment knowledge: A structural equation modeling analysis. *Personality and Individual Differences*, *113*, 96–102. https://doi.org/10.1016/j.paid.2017.03.023.

Nakawake, Y., & Sato, K. (2019). Systematic quantitative analyses reveal the folk-zoological knowledge embedded in folktales. *Palgrave Communications*, *5*(1), 161. https://doi.org/10.1057/s41599-019-0375-x.

Nave, G., Rentfrow, J., & Bhatia, S. (2020). We are what we watch: Movie plots predict the personalities of those who "like" them (preprint). *PsyArXiv*. https://doi.org/10.31234/osf.io/wsdu8.

Neidhardt, F. C., & Curtiss, R. (Eds.). (1996). *Escherichia coli and Salmonella: Cellular and molecular biology* (2nd ed). ASM Press.

Nettle, D. (2005a). The wheel of fire and the mating game: Explaining the origins of tragedy and comedy. *Journal of Cultural and Evolutionary Psychology*, *3*(1), 39–56. https://doi.org/10.1556/JCEP.3.2005.1.3.

Nettle, D. (2005b). Exploring the psychological foundations of drama. In J. Gottschall & D. S. Wilson (Eds.), *The literary animal: Evolution and the nature of narrative* (pp. 56–75). Northwestern University Press. https://doi.org/10.2307/j.ctvw1d5h1.

Nettle, D. (2019). State-dependent cognition and its relevance to cultural evolution. *Behavioural Processes*, *161*, 101–107. https://doi.org/10.1016/j.beproc.2018.01.018.

Nguyen, C. T. (2019). Games and the art of agency. *The Philosophical Review*, *128*(4), 423–462. https://doi.org/10.1215/00318108-7697863.

Nitsche, M. (2008). *Video game spaces: Image, play, and structure in 3D game worlds*. MIT Press.

Norris, P., & Inglehart, R. (2004). *Sacred and secular: Religion and politics worldwide* (1st ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511791017.

Omar, B., & Dequan, W. (2020). Watch, share or create: The influence of personality traits and user motivation on TikTok Mobile video usage. *International Journal of Interactive Mobile Technologies (IJIM)*, *14*(04), 121. https://doi.org/10.3991/ijim.v14i04.12429.

Organization for Economic Co-Operation and Development (2017). Indicator A1 To what level have adults studied? *Education at a glance 2017*. OECD Indicators. https://doi.org/10.1787/eag-2017-7-en

Oudeyer, P.-Y., Gottlieb, J., & Lopes, M. (2016). Intrinsic motivation, curiosity, and learning. In *Progress in brain research* (Vol. 229, pp. 257–284). Elsevier. https://doi.org/10.1016/bs.pbr.2016.05.005.

Paige, N. (2018). The artifactuality of narrative form. *Poetics Today*, *39*(1), 41–65. https://doi.org/10.1215/03335372-4265059.

Paige, N. D. (2011). *Before fiction: The ancien régime of the novel* (1st ed). University of Pennsylvania Press.

Paige, N. D. (2020). *Technologies of the novel*. Cambridge University Press.

Panksepp, J. (2005). *Affective neuroscience: The foundations of human and animal emotions*. Oxford University Press.

Pavel, T. G. (2017). *Univers de la fiction: Postface inédite*. Points Essais.

Pazzaglia, F., Meneghetti, C., & Ronconi, L. (2018). Tracing a route and finding a shortcut: The working memory, motivational, and personality factors involved. *Frontiers in Human Neuroscience*, *12*, 225. https://doi.org/10.3389/fnhum.2018.00225.

Peeler, D. F., & Nowakowski, R. S. (1987). Genetic factors and the measurement of exploratory activity. *Behavioral and Neural Biology*, *48*(1), 90–103. https://doi.org/10.1016/S0163-1047(87)90619-4.

Piantadosi, S. T., & Kidd, C. (2016). Extraordinary intelligence and the care of infants. *Proceedings of the National Academy of Sciences*, *113*(25), 6874–6879. https://doi.org/10.1073/pnas.1506752113.

Piccardi, L., Leonzi, M., D'Amico, S., Marano, A., & Guariglia, C. (2014). Development of navigational working memory: Evidence from 6- to 10-year-old children. *British Journal of Developmental Psychology*, *32*(2), 205–217. https://doi.org/10.1111/bjdp.12036.

Pinker, S. (1997). *How the mind works* (norton pbk). Norton.

Platt, M. L., & Brannon, E. M. (1996). Differences in feeding ecology predict differences in performance between golden lion tamarins (*Leontopithecus rosalia*) and Wied's mannosets (*Callithrix kuhli*) on spatial and visual memory tasks. *Animal Learning & Behavior*, *24*(4), 384–393.

Plebanek, D. J., & Sloutsky, V. M. (2017). Costs of selective attention: When children notice what adults miss. *Psychological Science*, *28*(6), 723–732. https://doi.org/10.1177/0956797617693005.

Poch, R., & Martin, B. (2015). Effects of intrinsic and extrinsic motivation on user-generated content. *Journal of Strategic Marketing*, *23*(4), 305–317. https://doi.org/10.1080/0965254X.2014.926966.

Polizzi di Sorrentino, E., Sabbatini, G., Truppa, V., Bordonali, A., Taffoni, F., Formica, D., Baldassarre, G., … Visalberghi, E. (2014). Exploration and learning in capuchin monkeys (*Sapajus* spp.): The role of action–outcome contingencies. *Animal Cognition*, *17*(5), 1081–1088. https://doi.org/10.1007/s10071-014-0740-5.

Poor, N. (2014). Computer game modders' motivations and sense of community: A mixed-methods approach. *New Media & Society*, *16*(8), 1249–1267. https://doi.org/10.1177/1461444813504266.

Postel, P. (2019). *Comment la fiction vint aux chinois* (Colloque "Fiction et culture").

Proctor, W., & McCulloch, R. (2016). Exploring imaginary worlds: Audiences, fan cultures and geographies of the imagination. *13*(1), 9.

Purhonen, S., Gronow, J., & Rahkonen, K. (2009). Social differentiation of musical and literary taste patterns in Finland. *Research on Finnish Society*, *2*, 39–49.

Rebora, S. (2016). On fantasy's transmediality: A cognitive approach. *Comparatismi*, *1*, 217–232. https://doi.org/10.14672/2016872.

Reed, P., & Adams, L. (1996). Influence of salient stimuli on rats' performance in an eight-arm radial maze. *Learning and Motivation*, *27*(3), 294–306. https://doi.org/10.1006/lmot.1996.0016.

Reed, P., Mitchell, C., & Nokes, T. (1996). Intrinsic reinforcing properties of putatively neutral stimuli in an instrumental two-lever discrimination task. *Animal Learning & Behavior*, *24*(1), 38–45. https://doi.org/10.3758/BF03198952.

Rich, A. S., & Gureckis, T. M. (2018). The limits of learning: Exploration, generalization, and the development of learning traps. *Journal of Experimental Psychology: General*, *147*(11), 1553–1570. https://doi.org/10.1037/xge0000466.

Rojas-Ferrer, I., Thompson, M. J., & Morand-Ferron, J. (2020). Is exploration a metric for information gathering? Attraction to novelty and plasticity in black-capped chickadees. *Ethology*, *126*(4), 383–392. https://doi.org/10.1111/eth.12982.

Rosati, A. G., & Hare, B. (2012). Chimpanzees and bonobos exhibit divergent spatial memory development: Spatial memory development in chimpanzees and bonobos. *Developmental Science*, *15*(6), 840–853. https://doi.org/10.1111/j.1467-7687.2012.01182.x.

Rosati, A. G., Rodriguez, K., & Hare, B. (2014). The ecology of spatial memory in four lemur species. *Animal Cognition*, *17*(4), 947–961. https://doi.org/10.1007/s10071-014-0727-2.

Rubenstein, J. (1967). Maternal attentiveness and subsequent exploratory behavior in the infant. *Child Development*, *38*(4), 1089. https://doi.org/10.2307/1127106.

Ruso, B., Renninger, L., & Atzwanger, K. (2003). Human habitat preferences: A generative territory for evolutionary aesthetics research. In E. Voland & K. Grammer (Eds.), *Evolutionary Aesthetics* (pp. 279–294). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-662-07142-7_10.

Ryan, M.-L. (1991). *Possible worlds, artificial intelligence, and narrative theory*. Indiana University Press.

Ryan, M.-L. (2014). Space. *The living handbook of narratology*. https://www.lhn.uni-hamburg.de/node/55.html.

Saad, G. (2012). Nothing in popular culture makes sense except in the light of evolution. *Review of General Psychology*, *16*(2), 109–120. https://doi.org/10.1037/a0027906.

Saad, G., & Gill, T. (2000). Applications of evolutionary psychology in marketing. *Psychology & Marketing*, *17*(12), 1005–1034.

Safra, L., Chevallier, C., Grèzes, J., & Baumard, N. (2020). Tracking historical changes in trustworthiness using machine learning analyses of facial cues in paintings. *Nature Communications*, *11*(1), 4728. https://doi.org/10.1038/s41467-020-18566-7.

Saler, M. T. (2012). *As if: Modern enchantment and the literary pre-history of virtual reality*. Oxford University Press.

Salmon, C., & Symons, D. (2004). Slash fiction and human mating psychology. *Journal of Sex Research*, *41*(1), 94–100. https://doi.org/10.1080/00224490409552217.

Schaeffer, J.-M. (1999). *Pourquoi la fiction?* Seuil.

Schniter, E., Wilcox, N. T., Beheim, B. A., Kaplan, H. S., & Gurven, M. (2018). Information transmission and the oral tradition: Evidence of a late-life service niche for tsimane amerindians. *Evolution and Human Behavior*, *39*(1), 94–105. https://doi.org/10.1016/j.evolhumbehav.2017.10.006.

Scholes, R., & Rabkin, E. S. (1977). *Science fiction: History, science, vision*. Oxford University Press.

Schultz, W. (1998). Predictive reward signal of dopamine neurons. *Journal of Neurophysiology*, *80*(1), 1–27. https://doi.org/10.1152/jn.1998.80.1.1.

Schultz, W. (2015). Neuronal reward and decision signals: From theories to data. *Physiological Reviews*, *95*(3), 853–951. https://doi.org/10.1152/physrev.00023.2014.

Schulz, E., & Gershman, S. J. (2019). The algorithmic architecture of exploration in the human brain. *Current Opinion in Neurobiology*, *55*, 7–14. https://doi.org/10.1016/j.conb.2018.11.003.

Schulz, E., Wu, C. M., Ruggeri, A., & Meder, B. (2019). Searching for rewards like a child means less generalization and more directed exploration. *Psychological Science*, *30*(11), 1561–1572.

Scott-Phillips, T., Blancke, S., & Heintz, C. (2018). Four misunderstandings about cultural attraction. *Evolutionary Anthropology: Issues. News, and Reviews*, *27*(4), 162–173. https://doi.org/10.1002/evan.21716.

Searle, J. R. (1975). The logical Status of fictional discourse. *New Literary History*, *6*(2), 319. https://doi.org/10.2307/468422.

Serafini, L. (1981). *Codex Seraphinianus*. Rizzoli.

Sibley, C. G., & Duckitt, J. (2008). Personality and prejudice: A meta-analysis and theoretical review. *Personality and Social Psychology Review*, *12*(3), 248–279. https://doi.org/10.1177/1088868308319226.

Silvey, R., & MacKeith, S. (1988). The paracosm: A special form of fantasy. *Organizing early experience: Imagination and cognition in childhood* (pp. 173–179). Routledge.

Sim, Z. L., & Xu, F. (2017a). Learning higher-order generalizations through free play: Evidence from 2- and 3-year-old children. *Developmental Psychology*, *53*(4), 642–651. https://doi.org/10.1037/dev0000278.

Sim, Z. L., & Xu, F. (2017b). Infants preferentially approach and explore the unexpected. *British Journal of Developmental Psychology*, *35*(4), 596–608. https://doi.org/10.1111/bjdp.12198.

Singh, M. (2020). Subjective selection and the evolution of complex culture. 21.

Singh, M. (2021). The sympathetic plot, its psychological origins, and implications for the evolution of fiction. *Emotion Review*, *13*(3), 183–198.

Snell-Rood, E., & Snell-Rood, C. (2020). The developmental support hypothesis: Adaptive plasticity in neural development in response to cues of social support. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1803), 20190491. https://doi.org/10.1098/rstb.2019.0491.

Sol, D., Sayol, F., Ducatez, S., & Lefebvre, L. (2016). The life-history basis of behavioural innovations. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1690), 20150187. https://doi.org/10.1098/rstb.2015.0187.

Song, H. (2013). Chinese Science fiction: A response to modernization. *Science Fiction Studies*, *40*. https://doi.org/10.5621/SCIEFICTSTUD.40.1.0015.

Sorić, I., Penezić, Z., & Burić, I. (2017). The Big five personality traits, goal orientations, and academic achievement. *Learning and Individual Differences*, *54*, 126–134. https://doi.org/10.1016/j.lindif.2017.01.024.

Sotamaa, O. (2010). When the game is not enough: Motivations and practices among computer game modding culture. *Games and Culture*, *5*(3), 239–255. https://doi.org/10.1177/1555412009359765.

Sperber, D. (1996). *Explaining culture: A naturalistic approach*. Blackwell.

Sperber, D., & Hirschfeld, L. A. (2004). The cognitive foundations of cultural stability and diversity. *Trends in Cognitive Sciences*, *8*(1), 40–46. https://doi.org/10.1016/j.tics.2003.11.002.

Spivey, J., Barrett, D., Padilla, E., & Gonzalez-Lima, F. (2008). Mother–infant separation leads to hypoactive behavior in adolescent Holtzman rats. *Behavioural Processes*, *79*(1), 59–65. https://doi.org/10.1016/j.beproc.2008.05.002.

Stansfield, K. H., & Kirstein, C. L. (2006). Effects of novelty on behavior in the adolescent and adult rat. *Developmental Psychobiology*, *48*(1), 10–15. https://doi.org/10.1002/dev.20127.

Stephens, D. W., Brown, J. S., & Ydenberg, R. C. (2014). *Foraging Behavior and Ecology*.

Stevens, J. R., Rosati, A. G., Ross, K. R., & Hauser, M. D. (2005). Will travel for food: Spatial discounting in two new world monkeys. *Current Biology*, *15*(20), 1855–1860. https://doi.org/10.1016/j.cub.2005.09.016.

Sugiyama, M. (2021). Co-occurrence of ostensive communication and generalizable knowledge in forager storytelling: Cross-cultural evidence of teaching in forager societies. *Human Nature*, *32*(1), 279–300. https://doi.org/10.1007/s12110-021-09385-w.

Sugiyama, S. (1996). On the origins of narrative: Storyteller bias as a fitness-enhancing strategy. *Human Nature*, *7*(4), 403–425. https://doi.org/10.1007/BF02732901.

Sugiyama, S. (2001). Food, foragers, and folklore: The role of narrative in human subsistence. *Evolution and Human Behavior*, *22*(4), 221–240. https://doi.org/10.1016/S1090-5138(01)00063-0.

Sumner, E., Li, A. X., Perfors, A., Hayes, B. K., Navarro, D. J., & Sarnecka, B. W. (2019a). *The Exploration Advantage*: 11.
Sumner, E., Steyvers, M., & Sarnecka, B. W. (2019b). It's not the treasure, it's the hunt: Children are more explorative on an explore/exploit task than adults. In A. K. Goel, C. M. Seifert, & C. Freksa (Eds.), *Proceedings of the 41st annual conference of the Cognitive Science Society* (pp. 2891–2897). Cognitive Science Society.
Sun, Y., Dong, X., & McIntyre, S. (2017). Motivation of user-generated content: Social connectedness moderates the effects of monetary rewards. *Marketing Science*, *36*(3), 10.
Sutton, R. S. (1990). Integrated architectures for learning, planning, and reacting based on approximating dynamic programming. In *Machine learning proceedings* 1990 (pp. 216–224). Elsevier. https://doi.org/10.1016/B978-1-55860-141-3.50030-4.
Tan, E. S. (2018). A psychology of the film. *Palgrave Communications*, *4*(1), 82. https://doi.org/10.1057/s41599-018-0111-y.
Tanenbaum, K., & Tanenbaum, J. (2009). *Commitment to Meaning: A Reframing of Agency in Games*. 9.
Taylor, M., Mottweiler, C. M., Aguiar, N. R., Naylor, E. R., & Levernier, J. G. (2020). Paracosms: The imaginary worlds of middle childhood. *Child Development*, *91*(1), 164–178. https://doi.org/10.1111/cdev.13162.
Todorov, T. (2015). *Introduction à la littérature fantastique*. Éditions du Seuil.
Tolkien, J. R. R., & Tolkien, C. (2006). *The monsters and the critics and other essays*. HarperCollins.
Tomasello, M. (2019). *Becoming human: A theory of ontogeny*. The Belknap Press of Harvard University Press.
Tottenham, N., Shapiro, M., Flannery, J., Caldera, C., & Sullivan, R. M. (2019). Parental presence switches avoidance to attraction learning in children. *Nature Human Behaviour*, *3*(10), 1070–1077. https://doi.org/10.1038/s41562-019-0656-9.
Ulrich, R. S. (1979). Visual landscapes and psychological well-being. *Landscape Research*, *4*(1), 17–23. https://doi.org/10.1080/01426397908705892.
van Schaik, C. P., Burkart, J., Damerius, L., Forss, S. I. F., Koops, K., van Noordwijk, M. A., & Schuppli, C. (2016). The reluctant innovator: Orangutans and the phylogeny of creativity. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371* (1690), 20150183. https://doi.org/10.1098/rstb.2015.0183.
Vanderbeke, D. (2019). On love and marriage in popular genres. In D. Vanderbeke & B. Cooke (Eds.), *Evolution and popular narrative* (pp. 83–105). Brill Rodopi. https://doi.org/10.1163/9789004391161_006.
Veblen, T. (1899). *Theory of the leisure class* (New ed).
Verdolin, J. L. (2006). Meta-analysis of foraging and predation risk trade-offs in terrestrial systems. *Behavioral Ecology and Sociobiology*, *60*(4), 457–464. https://doi.org/10.1007/s00265-006-0172-6.
Verpooten, J., & Nelissen, M. (2010). Sensory exploitation and cultural transmission: The late emergence of iconic representations in human evolution. *Theory in Biosciences*, *129*(2–3), 211–221. https://doi.org/10.1007/s12064-010-0095-7.
Veyne, P. (1988). *Did the Greeks believe in their myths? An essay on the constitutive imagination*. University of Chicago Press.
Wade, S., & Kidd, C. (2019). The role of prior knowledge and curiosity in learning. *Psychonomic Bulletin & Review*, *26*(4), 1377–1387. https://doi.org/10.3758/s13423-019-01598-6.
Walton, K. L. (1993). *Mimesis as make-believe: On the foundations of the representational arts*. Harvard University Press.
Wang, M. Z., & Hayden, B. Y. (2019). Monkeys are curious about counterfactual outcomes. *Cognition*, *189*, 1–10. https://doi.org/10.1016/j.cognition.2019.03.009.
Weisberg, S. M., Schinazi, V. R., Newcombe, N. S., Shipley, T. F., & Epstein, R. A. (2014). Variations in cognitive maps: Understanding individual differences in navigation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *40*(3), 669–682. https://doi.org/10.1037/a0035261.
Wikipedia. (2021). List of highest-grossing media franchises. In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=List_of_highest-grossing_media_franchises&oldid=1028024361.
Wilson, R. C., Geana, A., White, J. M., Ludvig, E. A., & Cohen, J. D. (2014). Humans use directed and random exploration to solve the explore–exploit dilemma. *Journal of Experimental Psychology: General*, *143*(6), 2074–2081. https://doi.org/10.1037/a0038199.
Wolf, M. J. P. (2012). *Building imaginary worlds: The theory and history of subcreation*. Routledge.
Wolf, M. J. P. (2017a). *Revisiting imaginary worlds: A subcreation studies anthology*. Routledge.
Wolf, M. J. P. (2017b). World design. *The Routledge companion to imaginary worlds*. Routledge.
Wolf, M. J. P. (Ed.) (2021). *Exploring imaginary worlds: Essays on media, structure, and subcreation*. Routledge.
Wolf, M. J. P., & Perron, B. (Eds.) (2014). *The Routledge companion to video game studies*. Routledge.
Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist*, *35*(2), 151–175. https://doi.org/10.1037/0003-066X.35.2.151.
Zunshine, L. (2006). *Why we read fiction: Theory of mind and the novel*. Ohio State University Press.

Open Peer Commentary

It's not fiction if you believe it: How imaginary worlds are derived from imaginary realities

Jeffrey Jensen Arnett

Department of Psychology, Clark University, Worcester, MA 01610, USA
arnett@jeffreyarnett.com; www.jeffreyarnett.com

doi:10.1017/S0140525X21002120, e277

Abstract

Imaginary worlds are not a consequence of humans' exploratory tendencies as argued in the target article but a recent spinoff of a strong human tendency to create *imaginary realities*, that is, versions of how the world works that are fabricated (although we believe they are real) in order to allow us to believe we understand it and can control it.

The target article by Dubourg and Baumard (D&B) usefully draws our attention to the extraordinary human ability to imagine a version of the world that is quite different from what actually appears before us in daily life. However, their explanation for this ability, that it is derived from our propensity to explore novel environments, is unpersuasive. Instead, I propose here that our ability to create "imaginary worlds" is a reflection of a broader human tendency to create and share a version of reality that is compelling, comprehensible, and largely fabricated. As cultural animals, we create stories that explain why things happen as they do. However, in order for these stories to retain their full psychological power, we must believe they are not merely stories but descriptions of The Way Things Really Are. In short, we have a universal and immutable tendency to invent and believe in *imaginary realities*. The imaginary worlds described by D&B represent a recent form of play based on our ancient propensity for embracing imaginary realities.

The limitations of the "imaginary worlds" concept

D&B explain the appeal of imaginary worlds by stating that they "co-opt our preferences for exploration, which have evolved in humans and nonhuman animals alike, to propel individuals toward new environments and new sources of reward" (target article, abstract). This is a weak thesis. Rats and apes and most other creatures also are motivated to explore novel environments, yet they do not create imaginary worlds. The creation of imaginary worlds is a distinctly human ability, yet there is nothing distinctly human about D&B's thesis, so it fails to explain the phenomenon.

The authors of the target article present an evolutionary explanation for the recent invention of imaginary worlds that is equally flawed, claiming that "the late appearance of imaginary worlds [beginning in the 17th century] is explained by the evolution of the strength of exploratory preferences. For a long time, people's exploratory preferences were too weak to give rise to the production

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

of imaginary worlds in fictions. Economic development made such preferences adaptive in some populations, and only then could imaginary worlds appear and be culturally successful." Yet exploratory motivations have existed among hominins for hundreds of thousands of years, as evident in the original spread of hominins out of Africa, first to Asia and eventually to Europe (Tattersall & DeSalle, 2019). There was virtually no "economic development" during this long era, so that explanation for geographical explorations is questionable. On the contrary, explorations and migrations into new geographical regions, then as well as now, are far more likely to be motivated by dire conditions and local scarcity of resources (Black et al., 2011). In short, a better explanation is needed for the distinctly human capacity to create imaginary realities and the imaginary worlds based on them.

The essential functions of imaginary realities

A more plausible and compelling explanation for our creation of imaginary realities (and by extension imaginary worlds) is that they are at the heart of the human capacity for creating cultures. Over a century of anthropology has documented in glorious detail how every human culture has an elaborate set of cultural beliefs that explain why the world functions as it does (Shweder et al., 2007). In every culture, these beliefs are not merely based on physical reality but go far beyond, incorporating magical, fantastic, and supernatural elements to create an imaginary reality. What is extraordinary about our imaginary realities is that we have created them in every culture, but *without recognizing that they are imaginary*. We hold beliefs such as that natural forces have human-like consciousness; or that our deceased ancestors monitor us constantly; or that our group descended from another animal; or that our adversaries may cause us to become ill by looking at us malevolently; but we regard these imaginary realities as The Way Things Really Are, not as invented fictions (Harari, 2015; Tattersall & DeSalle, 2019).

Although imaginary realities distort our understanding of the physical world in myriad ways, in some respects imaginary realities are highly practical. Most importantly, they promote social cohesion and group cooperation, as cultural members' shared beliefs provide a foundation for a shared understanding of how the group should function and how responsibilities should be distributed (Rossano, 2010). Imaginary realities also provide a social identity that distinguishes "our" cultural group and enhances cohesion in the event of conflict with other groups (Scheepers & Ellemers, 2019).

In these respects, imaginary realities are related to the concept of *master narratives* that has become widely used in recent years (Hammack, 2008; McLean & Syed, 2015). However, the concept of imaginary realities recognizes that master narratives are not just practical and useful, they are also elaborate fabrications. They do not simply provide a sensible road map through life, they embellish that road map by connecting it at each point to interpretations that fictionalize it. Moreover, it is essential that the people believing in imaginary realities do not recognize them as fictions – lest they lose their psychological power.

The derivation of imaginary worlds from imaginary realities

In sum, our recently flourishing ability to create imaginary worlds that we do recognize as fiction, described in the target article, is derived from a more ancient ability to construct imaginary realities we believe actually exist. What distinguishes the modern era is that we have learned to create imaginary worlds that we recognize as fictions and enjoy them as entertainment. This occurred as human societies became more complex, literate, and affluent; we have created not only imaginary worlds but other diverse creative products, from musical works to architectural marvels to literature. But the original source of that ability is our propensity for creating imaginary worlds that we believe are real – not imaginary worlds, then, but imaginary realities.

Funding. None.

Conflict of interest. None.

References

Black, R., Adger, W. N., Arnell, N. W., Dercon, S., Geddes, A., & Thomas, D. (2011). The effect of environmental change on human migration. *Global Environmental Change*, *21*, S3–S11.

Hammack, P. L. (2008). Narrative and the cultural psychology of identity. *Personality and Social Psychology Review*, *12*(3), 222–247.

Harari, Y. N. (2015). *Sapiens: A brief history of humankind*. Harper.

McLean, K. C., & Syed, M. (2015). Personal, master, and alternative narratives: An integrative framework for understanding identity development in context. *Human Development*, *58*(6), 318–349.

Rossano, M. (2010). *Supernatural selection: How religion evolved*. Oxford University Press.

Scheepers, D., & Ellemers, N. (2019). Social identity theory. In K. Sassenberg and M. L. W. Vliek (Eds.), *Social psychology in action* (pp. 129–143). Springer Nature.

Shweder, R. A., Goodnow, J. J., Hatano, G., LeVine, R. A., Markus, H. R., & Miller, P. J. (2007). The cultural psychology of development: One mind, many mentalities. In R. M. Lerner (Ed.), *Handbook of child psychology* (Vol. 1, pp. 716–792). Wiley.

Tattersall, I., & DeSalle, R. (2019). *The accidental homo sapiens: Genetics, behavior, and free will*. Pegasus.

The development of the imagination and imaginary worlds

Sarah R. Beck[a] and Paul L. Harris[b]

[a]School of Psychology, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK and [b]Harvard Graduate School of Education, Harvard University, Cambridge, MA 02138, USA
s.r.beck@bham.ac.uk; paul_harris@gse.harvard.edu
https://www.birmingham.ac.uk/staff/profiles/psychology/beck-sarah.aspx; http://pharris.squarespace.com/

doi:10.1017/S0140525X21002272, e278

Abstract

Evidence from developmental psychology on children's imagination is currently too limited to support Dubourg and Baumard's proposal and, in several respects, it is inconsistent with their proposal. Although children have impressive imaginative powers, we highlight the complexity of the developmental trajectory as well as the close connections between children's imagination and reality.

Developmental evidence is one of the three key areas that Dubourg and Baumard (D&B) use to support their proposal. Specifically, they claim that children appear to be both highly exploratory and highly imaginative. Although both these claims might be true, a closer look at the developmental psychology literature is needed to make the case convincingly and to identify potential issues.

Developmental psychology presents a complex picture because different types of imaginative thinking emerge at different ages.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

For example, pretend play appears by 2 years (Harris & Kavanaugh, 1993), future thinking around 5 years (McCormack & Atance, 2011), counterfactual thinking between 3 and 6 years (Beck & Riggs, 2014), and creative problem solving between 5 and 8 years (Beck, Apperly, Chappell, Guthrie, & Cutting, 2011). There is very little research specifically on the development of thinking about imaginary worlds. The authors cite Taylor, Mottweiler, Aguiar, Naylor, & Levernier's (2020) study that surveyed 8- to 12-year-olds about whether they had "a special imaginary place that they think about a lot" as evidence that paracosms *can* be created by children. However, it was relatively uncommon for children to report creating imaginary worlds. Thus, only around 17% of 8- to 12-year-olds did so (compared, e.g., to around 50% reporting imaginary companions). Given that this is the age group where paracosms are thought to be most common, it seems that creating imaginary worlds is quite rare and emerges later than many other imaginative abilities.

D&B emphasise a broad range of imaginary worlds and their differences from reality: "far removed islands, locations in the future or the distant past, other planets, or environments in alternative history" (target article, sect. 2, para. 2). Because there is little developmental evidence showing that children create imaginary worlds, it is tempting to rely on the widespread view that children often engage with fantasy that is beyond what they experience in reality. Yet, when observing children's pretend play, we typically see them re-enacting mundane home or school scenes or pretending to enact a role they have personally experienced or seen on television. In fact, various lines of evidence indicate that much imaginative thinking is about the real world or its close cousins, rather than a distant or non-existent fantasy world (Harris, 2021). One rare study explored children's and adults' preferences for realistic or fantasy stories (both fictitious), for example, a realistic story "about a boy/girl with lots of brothers and sisters" and a fantasy story "about a boy/girl who lives on an invisible farm." Four- and five-year-olds showed no preference for either type of story over the other, and a preference for fantasy increased rather than decreased with age between children and adults (Barnes, Bernstein, & Bloom, 2015).

D&B underline the "uselessness" of information gained from imaginary worlds. But this contrasts with recent psychological accounts showing that using the imagination to think about reality can be particularly useful for children. For example, in a study of regret, 6- and 7-year-olds had to choose between two boxes. The box they picked contained fewer rewards than the unchosen box. Those children whose counterfactual thinking ("If I had picked the other box, I would have had the better prize") led to regret (feeling worse after the unchosen box's contents were revealed), were more likely to make rational decisions in the future, by choosing the alternative option (McCormack, Feeney, & Beck, 2020). In fact, we might even make the broader claim that thinking about imaginary worlds can increase our understanding of the real world. For example, when children read Harry Potter, they are learning about personal relationships and morality, as well as the rules of Quidditch.

D&B present evidence that preferences for consuming imaginary worlds decrease with age: books and films were studied by Purhonen, Gronow, and Rahkonen (2009) and Dubourg, Thouzeau, de Dampierre, and Baumard (2021), respectively. But the participants in these studies were adults, the youngest of whom were 18. This reflects a tendency in their account to group different ages together: "imaginary worlds should be more attractive to children, teenagers, and young adults" (target article, sect. 5.2). But to make an effective developmental argument we need to be precise about the ages at which abilities emerge and how they interact. In particular, the developmental evidence on exploratory behaviour refers to children and (rarely) adolescents rather than adults, so it is currently difficult to marry this with the evidence on adults' fiction preferences.

Nevertheless, it is encouraging to see an account of the imagination that draws on diverse areas of evidence and we hope that developmental evidence can be used to ground this kind of account. The challenges we offer could be addressed by a more precise account of children's imagination abilities and how those abilities relate to their changing exploratory tendencies. Developmental psychology can also take lessons from this account, which highlights the lack of research on imaginary worlds and the key distinction between producing and consuming imaginary elements.

Funding. None.

Conflict of interest. None.

References

Barnes, J. L., Bernstein, E., & Bloom, P. (2015) Fact or fiction? Children's preferences for real versus make-believe stories. *Imagination, Cognition, and Personality*, *34*, 243–258. https://doi.org/10.1177/0276236614568632.

Beck, S. R., Apperly, I. A., Chappell, J., Guthrie, C., & Cutting, N. (2011). Making tools isn't child's play. *Cognition*, *119*, 301–306. https://doi.org/10.1016/j.cognition.2011.01.003.

Beck, S. R., & Riggs, K. J. (2014). Developing thoughts about what might have been. *Child Development Perspectives*, *8*, 175–179. https://doi.org/10.1111/cdep.12082.

Dubourg, E., Thouzeau, V., de Dampierre, C., & Baumard, N. (2021). Exploratory preferences explain the cultural success of imaginary worlds in modern societies. *PsyArXiv*, 1–19. https://doi.org/10.31234/osf.io/d9uqs.

Harris, P. L. (2021). Early constraints on the imagination: The realism of young children. *Child Development*, *92*, 466–483. https://doi.org/10.1111/cdev.13487.

Harris, P. L., & Kavanaugh, R. D. (1993). Young children's understanding of pretense. *Monographs of the Society for Research in Child Development*, *58*, i–107. https://doi.org/10.2307/1166074.

McCormack, T., & Atance, C. M. (2011). Planning in young children: A review and synthesis. *Developmental Review*, *31*, 1–31. https://doi.org/10.1016/j.dr.2011.02.002.

McCormack, T., Feeney, A., & Beck, S. R. (2020). Regret and decision-making: A developmental perspective. *Current Directions in Psychological Science*, *29*, 346–350. https://doi.org/10.1177/0963721420917688.

Purhonen, S., Gronow, J., & Rahkonen, K. (2009). Social differentiation of musical and literary taste patterns in Finland. *Research on Finnish Society*, *2*, 39–49. https://doi.org/10.51815/fjsr.110689.

Taylor, M., Mottweiler, C. M., Aguiar, N. R., Naylor, E. R., & Levernier, J. G. (2020). Paracosms: The imaginary worlds of middle childhood. *Child Development*, *91*(1), e164–e178. https://doi.org/10.1111/cdev.13162.

Autism and the preference for imaginary worlds

Heather Browning[a] and Walter Veit[b]

[a]Department of Philosophy, Logic and Scientific Method, London School of Economics and Political Science, Centre for Philosophy of Natural and Social Science, London WC2A 2AE, UK and [b]The University of Sydney, School of History and Philosophy of Science, Sydney, NSW 2006, Australia
DrHeatherBrowning@gmail.com; https://www.heatherbrowning.net/
wrwveit@gmail.com; https://walterveit.com/

doi:10.1017/S0140525X21002211, e279

Abstract

Dubourg and Baumard mention a potential role for the human drive to systemise as a factor motivating interest in imaginary worlds. Given that hyperexpression of this trait has been linked with autism (Baron-Cohen, 2002, 2006), we think this raises interesting implications for how those on the autism spectrum may differ from the neurotypical population in their engagement with imaginary worlds.

Dubourg and Baumard (D&B) have developed an exciting integrative theoretical proposal for the evolutionary basis of our cultural fixation on imaginary worlds, based on our drive to explore and seek novel information about our environment. In passing, they mention another potential (complementary) explanation for the appeal of imaginary worlds, based on the cognitive mechanisms that drive us to a preference for systemisation, drawing on work by autism researcher Simon Baron-Cohen. Baron-Cohen (2002) argued that humans can be rated along the two dimensions of empathising and systemising, where systemising involves the drive to understand a system and how it operates. Autism, in his view, is associated with a lower score on the empathising dimension and a high score on the systemising dimension – they are "hyper-systemisers" (Baron-Cohen, 2006). More recent research conducted on a sample of over 600,000 individuals has supported this claim (Greenberg, Warrier, Allison, & Baron-Cohen, 2018).

This naturally leads to the thought that those with a higher systemisation drive would have a higher interest in the fictional worlds described; and in particular that those on the autism spectrum might show a strong interest. Although D&B do not speculate about how autism may relate to their hypothesis, we think there is something interesting here worth exploring, regarding how people on the autism spectrum might differ from the neurotypical population in their engagement with and preference for imaginary worlds. Anecdotally, there is something appealing to this line of enquiry. Both of the authors of this commentary are on the autism spectrum, and we both show a strong preference for fictions taking place within imaginary worlds, having spent far too much time on the works referred to by the authors (such as the Harry Potter series, the Marvel Cinematic Universe, One Piece, Naruto, Game of Thrones, Star Wars, and the like), having even written philosophical explorations of them (Browning & Veit, forthcoming).

A preference for "world-dominant" fiction, which focusses primarily on the details of the setting rather than the characters or narrative, is in fact commonly taken to be a trait associated with autism and matches well with this idea that autism relates to a higher systemising and lower empathising ability. Autism spectrum traits often include an "obsessive" focus with a subject matter – particularly the details of "closed systems" (Baron-Cohen, 2002); a trait that dovetails nicely with the "encyclopaedic impulse" described by D&B that fans of imaginary worlds regularly display. Imaginary fictional worlds provide a perfect closed system for one to investigate and systemise – unlike the real world, it is possible for one to gain a complete knowledge and understanding of all the facets of an imaginary world. Autism has often been associated with "geek" culture of the type that surrounds imaginary worlds. While this has not been well-explored in the academic literature, there are plenty of online discussion boards in which autistic individuals discuss the ways in which they feel their autism influences their preference for deep engagement with such imaginary worlds.

While all this theorizing on the links between a drive for systemising and engagement with fictional worlds remains speculative, it provides an interesting avenue for research both in terms of sex differences, as the authors suggest, and the effects of autism. The hypothesis provides testable predictions regarding the correlation of autistic traits and level of interest in world-dominant as opposed to story-dominant fictions. It would also be interesting to investigate the degree to which autism is related to creation of and engagement with "paratexts" such as online fanwikis that serve as a globally accessible resource for systemising all knowledge about the minute details of these worlds. Of course, we should expect differences to come in degree, rather than radical binary differences as autism, after all, is found on a spectrum and symptoms can differ.

Another potentially interesting question this could help answer is why individuals often seem to stick to a limited number of fictional worlds, exploring them in depth, rather than increasing novelty by expanding exploration more widely across the board. This is likely to be an instance of the exploration/exploitation trade off, where the latter of which can be divided into systemisation and successful information usage. After all, focus on one fictional story will inevitably consume time that could be spent on exploring others. If autism can be understood as hyper-systemisation, we may well have an excellent target system to study this side of the equation, with a hypothesis that more autistic individuals are more likely to stick to the details of a few fictional worlds, rather than engaging with a large number; a prediction consistent with the association of autism with a narrower range of interests (Baron-Cohen, 2006).

It is important to also note that research into autism is still in its infancy, and Baron-Cohen's work (alongside other work of autism researchers) has been criticized for its focus on verbal report among those with so-called high-functioning autism. With autism increasingly recognized as a broad spectrum, non-verbal autistics may not be well represented in theories developed using only those in the "high-functioning" part of the spectrum (Chapman & Veit, 2020a, 2020b). This may be important, as for example, it has been found that preference for fiction over non-fiction in children with autism correlates with their communicative abilities (Davidson & Ellis Weismer, 2018). There is obviously still then a lot to understand about autism itself, before any speculation of this type can be strongly empirically grounded. Here, we simply wish to offer a new model/hypothesis for a subset of the phenomena linked with autism – that is, systemisation and interest in imaginative worlds – in a spirit of scientific pluralism without thereby implying that this rules out other explanations (Veit, 2019). Despite these caveats, we remain optimistic that an evolutionary lens on autism may offer exciting new pathways for future research.

Funding. WV's research was supported under Australian Research Council's Discovery Projects funding scheme (project number FL170100160).

Conflict of interest. None.

References

Baron-Cohen, S. (2002). The extreme male brain theory of autism. *Trends in Cognitive Sciences*, 6(6), 248–254. https://doi.org/10.1016/S1364-6613(02)01904-6.

Baron-Cohen, S. (2006). The hyper-systemizing, assortative mating theory of autism. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 30(5), 865–872. https://doi.org/10.1016/j.pnpbp.2006.01.010.

Browning, H., & Veit, W. (forthcoming). Why are we here? Evangelion and the desperate search for meaning in life. In: Cotton, C., & Winters, A. M. (Eds.), *Neon genesis Evangelion and philosophy*. Open Court.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Chapman, R., & Veit, W. (2020a). The essence of autism: Fact or artefact? *Molecular Psychiatry*, *26*, 1440–1441. https://doi.org/10.1038/s41380-020-00959-1.
Chapman, R., & Veit, W. (2020b). Representing the autism spectrum. *The American Journal of Bioethics*, *20*(4), 46–48. https://doi.org/10.1080/15265161.2020.1730495.
Davidson, M. M., & Ellis Weismer, S. (2018). A preliminary investigation of parent-reported fiction versus non-fiction book preferences of school-age children with autism spectrum disorder. *Autism & Developmental Language Impairments*, *3*, 1–12. https://doi.org/10.1177/2396941518806109.
Greenberg, D. M., Warrier, V., Allison, C., & Baron-Cohen, S. (2018). Testing the empathizing–systemizing theory of sex differences and the extreme male brain theory of autism in half a million people. *Proceedings of the National Academy of Sciences*, *115*(48), 12152–12157. https://doi.org/10.1073/pnas.1811032115.
Veit, W. (2019). Model pluralism. *Philosophy of the Social Sciences*, *50*(2), 91–114. https://doi.org/10.1177/0048393119894897.

Socioecology and fiction

Nicholas Buttrick[a] and Shigehiro Oishi[b]

[a]School of Public and International Affairs, Princeton University, Princeton, NJ 08540, USA and [b]Department of Psychology, University of Virginia, Charlottesville, VA 22904, USA
buttrick@princeton.edu; www.nickbuttrick.com
soishi@virginia.edu; https://psychology.as.virginia.edu/oishi

doi:10.1017/S0140525X21002223, e280

Abstract

We argue that the generation and enjoyment of imaginary worlds do not necessarily rely on an evolved preference for exploration. Rather, we suggest that culture is shaped by socioecological facts on the ground, and we hypothesize about the role of residential mobility, specifically, as an important factor in the popularity of imagined spaces.

While we find it plausible that consumption of imaginary worlds satisfies a desire for exploration, we are less convinced that the contemporary surge in the production of such worlds is the outgrowth of an evolutionary-psychological process that has finally been given the proper environment to express itself (target article, sect. 5.3). Instead of relying on such an ultimate-level evolutionary story, we suggest that the popularity of such narratives better tracks something far more proximate, changes in the socioecological environment in which such literature is produced and consumed.

Socioecological psychology seeks to understand human behavior with reference to the social and physical worlds in which people are embedded, investigating how factors such as the built environment, population density, demographic diversity, political system, and economic conditions shape and are shaped by individual and group psychologies (e.g., Choi & Oishi, 2020; Oishi, 2014). Residential mobility, specifically, may be especially relevant when thinking about the growth of imaginary worlds. As people move from place to place, they gain greater firsthand experience of the potential for difference in the world – different people, different environments, and different ways of being (see e.g., Buttrick & Oishi, 2021). This sense that a world can be other than it currently is would seem to be central to the production and consumption of a robustly imaginary space (e.g., Trilling, 1950).

Empirically, it may be useful to think about the historical context in which these imaginary worlds were and were not created. We can point, for example, to the contemporaneous experiences of Ming China (1368–1664) and Western Europe. Ming China was at least as wealthy as England during the period of Shakespeare and Thomas Moore (Broadberry, Guan, & Li, 2018), and had a literary culture producing works as rich and renowned as *Journey to the West* and *The Plum in the Golden Vase*. So why was England at the forefront of the development of imaginary worlds, and not China?

One clear difference is that Ming China differed quite significantly from Europe in the degree to which it allowed its population to move. Thanks to the *baojia* system, most people were tied to their lands and the central government strongly discouraged voluntary residential mobility of any kind, extolling the importance of belonging to a place (Lary, 2012). By contrast, contemporary England was hypermobile – from the 1580s to the 1730s, it's estimated that nearly three-quarters of residents, men and women both, left the parish of their birth (Clark & Sounden, 1988). While England was more mobile than the rest of Western Europe during the seventeenth century (MacFarlane, 1991; Moch, 2009; Whyte, 2000), Western Europe had largely caught up by the eighteenth century (Hayhoe, 2016; see also Rosental, 1999). It may be no surprise then, that the list of imaginary worlds compiled by Wolf (2012) is so dominated, in the 1600s and 1700s, by French and English writers. As the everyday experiences of people involved changes in place, their appetites for cultural products echoed this variability of location.

Europe was not uniform in its patterns of mobility. Central Europe lagged a bit behind in its rate of residential mobility, and did not reach Western-European rates of mobility until the 1800s (Moch, 2009). One estimate has residential mobility rates in Germany roughly quadrupling from 1820 to 1880 (Hochstadt, 1999). This timeframe, for example, neatly matches the rise in popularity of the Brothers' Grimm's fairytales – an exemplar of alternate world-building. Initially published in 1812, they were relatively unpopular at first, with their popularity growing through the 1850s, eventually making it into the state curriculum of Prussia in the 1870s (Zipes, 2002), right at the nineteenth century peak of residential mobility; as Germany becomes more mobile, German writers appear with increasing frequency in Wolf's (2012) list.

Twentieth-century China also helps in thinking about the relationship between socioecology and the consumption of imaginary worlds, thanks to its severe swings in the official permissibility of changing one's residence. Residential mobility had a major peak in the 1920s and 1930s (Lary, 2012); with the rise of the Communist government came a return to a place-based system of citizenship, the *hukou*, which locked roughly 85% of the population in place, and by the 1980s, only 0.6% of this population were "not where they were supposed to be," that is, had moved from where they had been tied (Chan, 2016). The liberalization of the 1980s encouraged ruralites to move: Scholars argue that China is now amongst the most mobile societies in the world, with as many as 200 million migrants (Fan, 2008). As the authors point out, science fiction first becomes popular in the late Qing and early-Republican era (mapping on to the first twentieth century wave of residential mobility), and again becomes popular at the turn of the twentieth century, right in the middle of the unprecedented boom in mobility set off by the end of the *hukou* system in the 1980s.

[We would also note that in their empirical paper (Dubourg, Thouzeau, de Dampierre, & Baumard, 2021), the authors find that the share of speculative novels, as a proportion of novels in general, peaks in the 1970s and dips thereafterwards. They may not realize it, but this is a trend that cleanly maps on to the pattern of American residential mobility in the twentieth century (Buttrick & Oishi, 2021), and not the linearly-increasing rise in American GDP (U.S. Bureau of Economic Analysis, 2021).]

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

In sum then, we argue that there is no need to propose a grand evolutionary theory of the imagined world, when one can point to a perhaps humbler, more parsimonious, hypothesis: that the cultural production of a society is influenced by the ways in which the experiences of everyday people are shaped by the sociological, economic, and demographic features of their worlds (e.g., Marx, 1852/1998).

Funding. None.

Conflict of interest. None.

References

Broadberry, S., Guan, H., & Li, D. (2018). China, Europe, and the great divergence: A study in historical national accounting, 980–1850. *The Journal of Economic History*, *78*(4), 955–1000.

Buttrick, N., & Oishi, S. (2021). The cultural dynamics of declining residential mobility. *American Psychologist*, *76*(6), 904–916.

Chan, K. W. (2016). Five decades of the Chinese hukou system. In Iredale, R. R., & Guo, F. (Eds.), *Handbook of Chinese migration: Identity and well-being* (pp. 23–47). Elgar.

Choi, H., & Oishi, S. (2020). The psychology of residential mobility: A decade of progress. *Current Opinion in Psychology*, *32*, 72–75.

Clark, P., & Sounden, D. (1988). *Migration and society in early modern England*. Hutchinson.

Dubourg, E., Thouzeau, V., de Dampierre, C., & Baumard, N. (2021, February 16). Exploratory preferences explain the cultural success of imaginary worlds in modern societies. *PsyArxiv*, 1–19. https://doi.org/10.31234/osf.io/d9uqs.

Fan, C. C. (2008). *China on the move: Migration, the state, and the household*. Routledge.

Hayhoe, J. (2016). *Strangers and neighbours: Rural migration in eighteenth-century northern Burgundy*. University of Toronto Press.

Hochstadt, S. (1999). *Mobility and modernity: Migration in Germany 1820–1989*. University of Michigan Press.

Lary, D. (2012). *Chinese migrations: The movement of people, goods, and ideas over four millennia*. Rowman & Littlefield Publishers.

MacFarlane, A. (1991). *The origins of English individualism*. Wiley-Blackwell.

Marx, K. (1852/1998). *The eighteenth Brumaire of Louis Bonaparte*. D. de Leon (Trans.). Project Gutenberg. https://www.gutenberg.org/files/1346/1346-h/1346-h.htm.

Moch, L. P. (2009). *Moving Europeans: Migration in Western Europe since 1650* (2nd ed.). Indiana University Press.

Oishi, S. (2014). Socioecological psychology. *Annual Review of Psychology*, *65*, 581–609.

Rosental, P.-A. (1999). *Les sentiers invisibles: Espaces, familles et migrations dans la France du 19e siecle*. Editions de l'EHESS.

Trilling, L. (1950). *The liberal imagination: Essays on literature and society*. Viking.

U.S. Bureau of Economic Analysis (2021). *Gross domestic product*. https://fred.stlouisfed.org/series/GDP.

Whyte, I. D. (2000). *Migration and society in Britain, 1550–1830*. Macmillan International Higher Education.

Wolf, M. J. P. (2012). *Building imaginary worlds: The theory and history of subcreation*. Routledge.

Zipes, J. (2002). *The Brothers Grimm: From enchanted forests to the modern world* (2nd ed.). Routledge.

Cognitive exploration drives engagement and re-engagement with imaginary worlds, but not spatial exploration as predicted by evolutionary theory

Rebecca Dunk and Raymond A. Mar

Department of Psychology, York University, Toronto, ON M3J 1P3, Canada
rjdunk@yorku.ca; https://rebeccajoydunk.wixsite.com/researcher
mar@yorku.ca; yorku.ca/mar/

doi:10.1017/S0140525X21002168, e281

Abstract

The empirical evidence for exploration underlying the appeal of imaginary worlds is mostly absent or contradictory. Openness, and the cognitive exploration it represents, provides a better account than the overall drive to explore predicted by evolutionary theory. Furthermore, exploration cannot explain why imaginary worlds foster frequent re-engagement.

Understanding the appeal of fiction requires a nuanced approach. For this reason, we greatly appreciate how the authors focused on imaginary worlds, avoiding the common pitfall of giving narrow explanations for the broad entirety of fiction. Overall, the theoretical account put forth is intriguing and plausible, and provides some logical predictions about when and by whom imaginary worlds are most likely to be appreciated. Unfortunately, the definition for imaginary worlds put forth is inconsistent in its exclusion of religious narratives and the rationale for doing so (e.g., the Epic of Gilgamesh), and appears circular in constraining these narratives to those that fit the hypothesis. Most problematically, however, the available empirical evidence to support the theory's predictions is absent and at times even contradictory.

In several instances, the evidence cited in support of empirical questions is non-empirical in nature, or unpublished and not available for examination or critique. As examples, the claim that exploration correlates with a preference for cognitive tasks is supported by an unpublished conference presentation (Hills & Stroup, 2004), and the assertion that sci-fi readers are more politically progressive is supported by what appears to be conjecture from a literary scholar (Besson, 2021). Several other instances of non-empirical, theoretical evidence being cited in support of empirical claims occur throughout (e.g., regarding resource collection, cooperation and cheating, signalling cooperative partners; André, Baumard, & Boyer, 2020; Boon-Falleur, Baumard, & André, 2020; Mell, Baumard, & André, 2019; Singh, 2019). Although it is laudable that the theory proposed generates testable empirical questions, the evidence cited in support of these empirical claims is largely unpublished or non-empirical in nature.

Moreover, some of the empirical evidence that is available contradicts the theory. The article rightfully points out that if exploration drives an appreciation for imaginary worlds, than the meta-trait Plasticity should predict this appreciation. Plasticity is indeed closely linked to exploration (Aluja, García Óscar, & García Luís, 2003; DeYoung, 2013) and a consistent predictor of related constructs like sensation-seeking and approach behaviours (Hirsh, DeYoung, & Peterson, 2009; Olson, 2005). Importantly, Plasticity is equal parts Openness and Extraversion (DeYoung, Peterson, & Higgins, 2002), with the dopaminergic system responsible for exploration reflected in the interaction between these two traits (Fischer, Lee, & Verzijden, 2018). The evolutionary framing of the target article requires that Extraversion positively predict the appeal of imaginary worlds, given the importance of spatial exploration for information-seeking in human evolution. In actuality, Extraversion is negatively correlated with an appreciation for imaginary worlds (Dubourg, Thouzeau, de Dampierre, & Baumard, 2021). This negative association is difficult to explain if exploration is truly responsible for a drive to consume imaginary worlds; it appears to be direct evidence against the theory.

That said, one possible explanation for this result is that Extraversion is most strongly tied to Plasticity in stressful

environments. Extraversion's role in dopamine function and approach behaviours is strongest in the presence of climatic stress (Fischer et al., 2018). Unfortunately, this creates new problems as it implies that another main prediction of the theory should be reversed: imaginary worlds should be most appealing in stressful, unstable environments. This would be consistent with evidence that we explore when uncertainty is salient (DeYoung, 2013; Hirsh, Mar, & Peterson, 2012; Robbins & Arnsten, 2009). But this makes the rise in popularity of these imaginary worlds difficult to explain, especially if the primary consumers are those whose lives are made stable by affluence (Dubourg & Baumard [D&B] target article). The available evidence indicates that it is exclusively Openness that explains an attraction to imaginary worlds (Dubourg et al., 2021), and not Plasticity or Extraversion. We suggest that this is a direct result of the distinct difference between real-world and imaginary exploration. The latter is tied rather obviously to cognitive exploration, supported by Openness, as opposed to real-world exploration, which is linked to Extraversion.

As a final consideration, the popularity of re-engaging with known imaginary worlds also seems inconsistent with the main proposal of the target article. The frequently referenced imaginary worlds – *Star Wars*, *Lord of the Rings*, *Harry Potter* – all have ardent fan followings. Fans of these stories consistently re-engage with these imaginary worlds. Some report re-reading a series every year (Goodreads, n.d.) and others re-watch the movies in gruellingly long marathons (Wallis, 2020). If exploration is truly behind the popularity of these worlds, why re-visit them so often? "Re-consumption" is characterized by a foundational knowledge of the work and its components (Russell & Levy, 2012), which makes it inconsistent with a drive to explore and gather information. Although the prevalence of re-engagement with imaginary worlds challenges the primary thesis of the target article, it actually fits rather well with the pattern of associations observed for Openness and Extraversion. The tendency to re-read is driven by Openness (Ministero, Green, Gabriel, & Valenti, 2021), which supports our proposal that cognitive exploration is responsible for the appeal of imaginary worlds. Extraversion does not predict the tendency to re-read, suggesting that neither the general exploratory preference represented by Plasticity, nor the spatial exploration manifested by Extraversion, can explain the appeal of imaginary worlds.

In closing, we share the interest and enthusiasm for probing why, how, and for whom imaginary worlds are so popular. The target article succeeds in bringing this topic some well-deserved attention, by way of a thoughtful, systematic, and generative theoretical account. Unfortunately, the available empirical evidence, and real-world phenomena surrounding the (re-)consumption of imaginary worlds, indicates that this theory requires revision or substitution.

Funding. The authors gratefully acknowledge the support of the Social Sciences and Humanities Research Council (#435-2017-1030).

Conflict of interest. None.

References

Aluja, A., García, Ó., & García Luís F. (2003). Relationships among extraversion, openness to experience, and sensation seeking. *Personality and Individual Differences*, *35*(3), 671–680. https://doi.org/10.1016/s0191-8869(02)00244-1

André, J.-B., Baumard, N., & Boyer, P. (2020). *The mystery of symbolic culture: What fitness costs? What fitness benefits?* Open Science Framework. https://osf.io/kdh7t/download?format=pdf.

Besson, A. (2021). *Les pouvoirs de l'enchantement: Usages Politiques de la fantasy et de la science-fiction*. Vendémiaire.

Boon-Falleur, M., Baumard, N., & André, J.-B. (2020). *Risk-seeking or impatient? Disentangling variance and time in hazardous behaviors*. PsyArXiv. https://doi.org/10.31234/osf.io/phtm8.

DeYoung, C. G. (2013). The neuromodulator of exploration: A unifying theory of the role of dopamine in personality. *Frontiers in Human Neuroscience*, *7*. https://doi.org/10.3389/fnhum.2013.00762

DeYoung, C. G., Peterson, J. B., & Higgins, D. M. (2002). Higher-order factors of the big five predict conformity: Are there neuroses of health? *Personality and Individual Differences*, *33*(4), 533–552. https://doi.org/10.1016/s0191-8869(01)00171-4

Dubourg, E., Thouzeau, V., de Dampierre, C., & Baumard, N. (2021). Exploratory preferences explain the cultural success of imaginary worlds in modern societies. *PsyArXiv*, 1–19. https://doi.org/10.31234/osf.io/d9uqs.

Fischer, R., Lee, A., & Verzijden, M. N. (2018). Dopamine genes are linked to extraversion and neuroticism personality traits, but only in demanding climates. *Scientific Reports*, *8*(1). https://doi.org/10.1038/s41598-017-18784-y

Goodreads. (n.d.). *J.R.R. Tolkien – Lord of the Rings: How many times have you read The Lord of the Rings?* Goodreads. Retrieved from https://www.goodreads.com/topic/show/2047249-how-many-times-have-you-read-the-lord-of-the-rings.

Hills, T., & Stroup, W. (2004). Cognitive exploration and search behavior in the development of endogenous representations. In *Annual Meeting for the American Educational Research Association, San Diego, CA*.

Hirsh, J. B., DeYoung, C. G., & Peterson, J. B. (2009). Metatraits of the big five differentially predict engagement and restraint of behavior. *Journal of Personality*, *77*(4), 1085–1102. https://doi.org/10.1111/j.1467-6494.2009.00575.x

Hirsh, J. B., Mar, R. A., & Peterson, J. B. (2012). Psychological entropy: A framework for understanding uncertainty-related anxiety. *Psychological Review*, *119*(2), 304–320. https://doi.org/10.1037/a0026767

Mell, H., Baumard, N., & André, J.-B. (2019). *Time is money. Waiting costs explain why selection favors steeper time discounting in deprived environments*. EcoEvoRxiv. https://doi.org/10.32942/osf.io/7d56s.

Ministero, L. M., Green, M. C., Gabriel, S., & Valenti, J. (2021). Back where I belong: Rereading as a risk-free pathway to social connection. *Psychology of Aesthetics, Creativity, and the Arts*, *16*(1), 97–109. https://doi.org/10.1037/aca0000375.supp

Olson, K. R. (2005). Engagement and self-control: Superordinate dimensions of big five traits. *Personality and Individual Differences*, *38*(7), 1689–1700. https://doi.org/10.1016/j.paid.2004.11.003

Robbins, T. W., & Arnsten, A. F. T. (2009). The neuropsychopharmacology of fronto-executive function: Monoaminergic modulation. *Annual Review of Neuroscience*, *32*(1), 267–287. https://doi.org/10.1146/annurev.neuro.051508.135535

Russell, C. A., & Levy, S. J. (2012). The temporal and focal dynamics of volitional reconsumption: A phenomenological investigation of repeated hedonic experiences. *Journal of Consumer Research*, *39*(2), 341–359. https://doi.org/10.1086/662996

Singh, M. (2019). *The evolutionary and psychological foundations of universal narrative structure*. Open Science Framework. https://doi.org/10.31219/osf.io/p8q7a.

Wallis, A. (2020). *Calling all "star wars" fans: Showcase airing 9-Movie Marathon over Easter Weekend – National*. Global News. Retrieved September 21, 2021, from https://globalnews.ca/news/6798791/showcase-star-wars-marathon-easter/.

The allure of the unknown in a tamed, mapped, and homogenized world

Liane Gabora and Isabel Gomez

Department of Psychology (Okanagan Campus), University of British Columbia, Kelowna, BC V1V 1V7, Canada
liane.gabora@ubc.ca; https://people.ok.ubc.ca/lgabora/
mislabel.gomez@ubc.ca

doi:10.1017/S0140525X21002193, e282

Abstract

As the physical world becomes tamed and mapped out, opportunities to experience the unknown become rarer; imaginary worlds provide a much-needed sense of potentiality. Potentiality is central to the Self-Other Re-organization theory of cultural evolution, which postulates that creativity fuels cumulative cultural change.

We point to evidence that fear affects, not the magnitude of exploration, but how cautiously it proceeds.

We find the argument that our species' enjoyment of other worlds is related to the adaptive value of exploratory behavior to be highly plausible. We suggest that the authors' proposal can be extended by incorporating what has been referred to as the *adjacent possible* (Kauffman, 2019; Koppl, Kauffman, Felin, & Longo, 2015): the realm of what is just beyond reach. Exploratory behavior enables us to dip into the realm of what is "not quite actual" but rather, the halo of potentiality that is hinted at by what is actual. The appeal of imaginary worlds in the twenty-first century may be related to a radical change in our perception of the adjacent possible, given the rate at which our world has been tamed, mapped out, and homogenized. Compared to our ancestors' world, in which you could hop in a boat and have no idea what sort of exotic land you might encounter, our present world does not hold the same kind of mystery and intrigue. Imaginary worlds provide us with what the physical world offered our ancestors: a sense of potentiality, and a key to the unknown.

Research on concepts, and in particular, quantum models of concept interactions (e.g., Aerts, Aerts, & Gabora, 2009; Aerts, Broekaert, Gabora, & Sozzo, 2016), suggests that this sense of potentiality ultimately stems from how rigidly one's concepts (such as SKY) are tied to specific properties (e.g., "blue") and contexts (e.g., "Earth"). In quantum models of concepts, the state of full potentiality for a concept is referred to as its *ground state*, and in a particular context (e.g., the context "Mars"), the concept SKY "collapses" to an *actualized state* (e.g., the sky of Mars), with context-specific properties (e.g., the sky is red). Exposure to imaginary worlds may decrease mental rigidity by pushing concepts closer to their ground state of full potentiality, thereby enhancing the capacity for creative connections. This hypothesis is consistent with evidence that cognitive flexibility plays an important role in creativity (Dreu, Nijstad, & Baas, 2011). It is also consistent with studies showing that the creative process is conducive to holding the contents of working memory in a state of potentiality such that ambiguities and inconsistencies are tolerated, and different interpretations or affordances are considered, before gradually settling on a particular solution or outcome (Carbert, Gabora, Schwartz, & Ranjan, 2014; Gabora, 1998; Gabora & Saab, 2011; Scotney, Schwartz, Carbert, Adam Saab, & Gabora, 2020).

The authors claim that the existence of imaginary worlds is not explainable in terms of existing theories of cultural evolution. We suggest, however, that they *are* explainable in terms of the Self-Other Re-organization (SOR) theory of cultural evolution (Gabora, 2019; Smith, Gabora, & Gardner-O'Kearny, 2018; for mathematical models of SOR, see Gabora & Steel, 2017, 2020a, 2020b, 2021). SOC postulates that culture evolves, not through a Darwinian process of competitive exclusion and survival of the fittest, but through a largely cooperative process of internal self-maintenance and restructuring *within* individuals, interleaved with social interaction *between* individuals. Central to SOR is the notion that cultural outputs are the external evidence of internal change brought about by creativity, which transforms potentialities into actualities by tapping into the adjacent possible. SOR would attribute the existence of imaginary worlds to their capacity to enhance cognitive flexibility and provoke restructuring of one's internal model of the world, or worldview, leading to enhanced capacity to adapt to new circumstances, and thereby, accelerated cultural evolution. Support for this hypothesis comes from evidence that diversifying experiences enhance cognitive flexibility (Ritter et al., 2012); imaginary worlds are indeed the ultimate diversifying experience.

The authors' suggestion that imaginary worlds are more popular with individuals who are relatively well-off and enjoy a sense of safety (target article, sect. 4.4.2, para. 2) appears to be inconsistent with the notion of adversity as a form of creative capital, and evidence that agency evolves out of threatening or marginalized conditions (Forgeard, 2013; Riley & Gabora, 2012; Weston & Imas, 2018). Indeed, this body of research suggests a hypothesis quite contrary to that of the target paper: that those who are less fortunate may have an even greater appreciation of the sense of escape afforded by imaginary worlds. "Gallows humor," for example, may be evidence of the creativity-inspiring impact of adversity (Watson, 2011). Well-off individuals may simply be more aware of the existence of books and media with imaginary worlds, or more able to afford them, or possess more well-developed reading skills, or more free time.

We suggest that the notion that exploratory behavior in animals is inversely related to fear of predation is only partly true. In a study of exploratory behavior in killifish, although killifish from a high predation lake took *longer* to explore a new space, they would eventually explore it as thoroughly as killifish from a lake without predation (Gabora & Colgan, 1990). Thus, when space explored was plotted as a function of time, the curve for the killifish populations from the high predation lake was wider and flatter, but the total area under the curves was the same for both populations. This suggests that fear does not affect the magnitude of the drive to explore; it merely tempers it, such that exploration proceeds more cautiously, and takes longer.

We note that imaginary worlds do not appeal to everyone, nor does everyone feel compelled to create them. This is consistent with evidence from an agent-based computational model of cultural evolution which showed that the mean fitness and diversity of the artificial society's outputs was highest when there was a balance between novelty-*generating* innovators and novelty-*preserving* imitators (Gabora & Tseng, 2017). Innovators may be attracted to imaginary worlds because of their impact on mental flexibility (discussed above), whereas those who favor cultural continuity through the perpetuation of existing methods might tend to view imaginary worlds as merely frivolous.

Funding. This work was supported by a grant (62R06523) from the Natural Sciences and Engineering Research Council of Canada and funding to LG and her lab from Susan and Jacques Leblanc for research on creativity.

Conflict of interest. None.

References

Aerts, D., Aerts, S., & Gabora, L. (2009). Experimental evidence for quantum structure in cognition. In P. Bruza, W. Lawless, K. van Rijsbergen & D. Sofge (Eds.) *Lecture notes in computer science: Quantum interaction* (pp. 59–79). Springer.

Aerts, D., Broekaert, J., Gabora, L., & Sozzo, S. (2016). Generalizing prototype theory: A formal quantum framework. *Frontiers in Psychology* (Section: Cognition), *7*(418). doi: 10.3389/fpsyg.2016.00418

Carbert, N., Gabora, L., Schwartz, J., & Ranjan, A. (2014). Cognitive states of potentiality in art-making. In A. Kozbelt, P. Locher & P. Tinio (Eds.), *Proceedings of the IAEA congress on empirical aesthetics* (pp. 121–126). International Association of Empirical Aesthetics Press.

Dreu, C. K. D., Nijstad, B. A., & Baas, M. (2011). Behavioral activation links to creativity because of increased cognitive flexibility. *Social Psychological and Personality Science*, *2* (1), 72–80.

Forgeard, M. (2013). Perceiving benefits after adversity: The relationship between self-reported posttraumatic growth and creativity. *Psychology of Aesthetics, Creativity, Arts 7*, 245–264.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Gabora, L. (1998). Weaving, bending, patching, mending the fabric of reality: A cognitive science perspective on worldview inconsistency. *Foundations of Science*, *3*(2), 395–428.
Gabora, L. (2019). Creativity: Linchpin in the quest for a viable theory of cultural evolution. *Current Opinion in Behavioral Sciences*, *27*, 77–83.
Gabora, L., & Colgan, P. (1990). A model of the mechanisms underlying exploratory behavior. In S. Wilson & J. A. Mayer (Eds.), *Proceedings of first international conference on the simulation of adaptive behavior* (pp. 475–484). MIT Press.
Gabora, L., & Saab, A. (2011). Creative interference and states of potentiality in analogy problem solving. In L. Carlson, C. Hőlscher & T. F. Shipley (Eds.), *Proceedings of the 33rd annual meeting of the cognitive science society* (pp. 3506–3511). Cognitive Science Society.
Gabora, L., & Steel, M. (2020a). A model of the transition to behavioral and cognitive modernity using reflexively autocatalytic networks. *Journal of the Royal Society Interface*, *17*(171), 1720200545. http://doi.org/10.1098/rsif.2020.0545
Gabora, L., & Steel, M. (2020b). Modeling a cognitive transition at the origin of cultural evolution using autocatalytic networks. *Cognitive Science*, *44*(9), e12878. https://doi.org/10.1111/cogs.12878
Gabora, L., & Steel, M. (2021). An evolutionary process without variation and selection. *Journal of the Royal Society Interface*, *18*(180). 20210334. https://doi.org/10.1098/rsif.2021.0334
Gabora, L., & Steel, M. (2017). Autocatalytic networks in cognition and the origin of culture. *Journal of Theoretical Biology*, *431*, 87–95.
Gabora, L., & Tseng, S. (2017). The social benefits of balancing creativity and imitation: Evidence from an agent-based model. *Psychology of Aesthetics, Creativity, and the Arts*, *11*(4), 457–473.
Kauffman, S. A. (2019). *A world beyond physics: The emergence and evolution of life*. Oxford University Press.
Koppl, R., Kauffman, S., Felin, T., & Longo, G. (2015). Economics for a creative world. *Journal of Institutional Economics*, *11*(1), 1–31.
Riley, S., & Gabora, L. (2012). Evidence that threatening situations enhance creativity. In N. Miyake, D. Peebles & R. P. Cooper (Eds.) *Proceedings of the 34th annual meeting of the cognitive science society* (pp. 2234–2239). Cognitive Science Society.
Ritter, S. M., Damian, R. I., Simonton, D. K., van Baaren, R. B., Strick, M., Derks, J., & Dijksterhuis, A. (2012). Diversifying experiences enhance cognitive flexibility. *Journal of Experimental Social Psychology*, *48*(4), 961–964.
Scotney, V., Schwartz, J., Carbert, C., Adam Saab, A., & Gabora, L. (2020). The form of a 'half-baked' creative idea: Empirical explorations into the structure of ill-defined mental representations. *Acta Psychologica*, *202*, 102983. https://doi.org/10.1016/j.actpsy.2019.102981
Smith, C., Gabora, L., & Gardner-O'Kearny, W. (2018). The extended evolutionary synthesis facilitates evolutionary models of culture change. *Cliodynamics: The Journal of Quantitative History and Cultural Evolution*, *9*(2), 84–107.
Watson, K. (2011). Gallows humor in medicine. *Hastings Center Report*, *41*(5), 37–45.
Weston, A., & Imas, J. M. (2018) Creativity: Transformation of adversity. In L. Martin & N. Wilson (Eds.), *The Palgrave handbook of creativity at work* (pp. 287–307). Palgrave Macmillan, https://doi.org/10.1007/978-3-319-77350-6_14.

Using imaginary worlds for real social benefits

Shira Gabriel[a], Melanie C. Green[a], Esha Naidu[a] and Elaine Paravati[b]

[a]Department of Psychology, University at Buffalo (SUNY), Buffalo, NY 14260, USA and [b]Department of Psychology, Hamilton College, Clinton, NY 13323, USA
sgabriel@buffalo.edu
mcgreen2@buffalo.edu
eshanaid@buffalo.edu
eharriga@hamilton.edu
https://arts-sciences.buffalo.edu/psychology/faculty/faculty-directory/gabriel.htmlwww.buffalo.edu/cas/communication/faculty/green.html

doi:10.1017/S0140525X21002181, e283

Abstract

We argue that imaginary worlds gain much of their appeal because they fulfill the fundamental need of human beings to feel connected to other humans. Immersion into story worlds provides a sense of social connection to the characters and groups represented in the world. By fulfilling the need to belong, imaginary worlds provide a buffer against rejection and loneliness.

Dubourg and Baumard (D&B) propose that imaginary worlds are powerful, universal, and common because they tap into the human preference for exploration. Although this motivation may capture some of the appeal of fictional worlds, we argue that they gain the bulk of their appeal because they fulfill the fundamental and powerful need to feel connected to others. Humans require the experience of inclusion and connectedness much the same way they require food and shelter (Baumeister & Leary, 1995). Early humans only survived if they were accepted into collectives that protected and supported them (Stevens & Fiske, 1995). Purportedly, the survival value of collective life for our evolutionary ancestors led to the evolution of internal mechanisms that impel modern humans to collectives (Caporael & Brewer, 1995; Wilson, 1978).

These primitive and powerful internal mechanisms predispose humans to feel connections to all kinds of groups, real and imagined. People easily and quickly assimilate collective identities, even on the basis of the most minimal criteria (e.g., Tajfel, 1970). Once formed, collective bonds enhance well-being (Cohen & Willis, 1985; Ellemers, De Gilder, & Haslam, 2004; Haslam, O'Brien, Jetten, Vormedal, & Penna, 2005). Narratives provide a key platform for feeling connected to collectives. Our research suggests that narratives pull people into the social worlds described within, make them feel as if they are members of those social worlds, and thus fill their need to belong. The first step in this process involves people being transported into narrative worlds (Green & Brock, 2000). The cognitive, emotional, and imagery engagement created by being transported into a narrative makes the imaginary world seem real (Green, 2004).

Once readers are immersed in the narrative world, *narrative collective assimilation* occurs. In other words, experiencing narratives leads one to psychologically become a part of the collective described within the narrative (Gabriel & Young, 2011). In one study, participants read passages from either the *Harry Potter* or *Twilight* books. Utilizing both the Implicit Association Test and an identity scale, we found that participants who read *Harry Potter* psychologically became wizards, whereas those who read *Twilight* psychologically became vampires. Additionally, the degree to which the participants assimilated the social world predicted increases in two primary outcomes of belonging: life satisfaction and mood. Thus, our work supported the hypothesis that reading narratives lead to assimilation of the collectives within the narratives, which then bolstered feelings of social connection.

In addition to narrative collective assimilation, individuals can also form parasocial relationships with characters (e.g., a *Harry Potter* reader may view Harry as a friend). During repeated exposure to characters within a narrative, individuals form insights into the character's beliefs, perspectives, and worldviews (Frith & Frith, 2006; Mar & Oatley, 2008). They often intentionally or unintentionally mentally simulate what interacting with this character would be like, and develop empathy with the character. This sense of intimacy and understanding of the character can lead to the development of a parasocial relationship (Derrick, Gabriel, & Tippin, 2008). These connections

with fictional others involve the same kind of mental models of the self, others, and social groups as in actual interpersonal relationships, and similarly provide a sense of belongingness (Gabriel, Valenti, Naragon-Gainey, & Young, 2017; Paravati, Naidu, & Gabriel, 2021).

Evidence for the belongingness function of narratives also comes from work suggesting that it can protect against the harmful effects of rejection, social isolation, and loneliness (Derrick et al., 2008). People reported turning to favored television programs when feeling lonely, as well as feeling less lonely when viewing those programs. In addition, writing about their favorite television show buffered against the drops in self-esteem and mood commonly elicited by threats to close relationships. These valued television programs can provide the experience of belongingness and protect against the negative consequences of social isolation and exclusion.

Although we have yet to examine how imaginary narratives compare to realistic narratives in filling belongingness needs, there is reason to believe that imaginary narratives may be especially powerful. Creating an imaginary world involves the writer dedicating precious story time to explaining the social world, how it functions, and what it looks like. This detailed world-building should increase transportation and narrative collective assimilation. Indeed, research from our laboratory suggests that more time spent in a narrative world, the more likely one is to assimilate to it and feel connection (Ministero, Green, Gabriel, & Valenti, 2022). Furthermore, some realistic fictional worlds may resemble one's real life too much to allow the reader to truly mentally escape to the imaginary world and become a part of it, bypassing the specific pressures, threats, and prejudices that exist for many in more realistic worlds. In other words, in more realistic fiction, one's real life may remain salient and transportation may become less likely.

In contrast to the D&B's emphasis on the primacy of exploration, our research finds that imaginary worlds are appealing even when they are familiar, as evidenced by the frequency with which individuals re-read and re-watch favorite stories. Revisiting a familiar narrative world provides comfort and predictable emotional experiences for readers, qualities which may be especially appealing to individuals with unfulfilled social needs (Ministero et al., 2022). For some individuals, being a fan of particular books, movies, or television series may create a sense of belonging through both repeated exposure to the narrative as well as connections with others who share their enthusiasm (Vinney, Dill-Shackleford, Plante, & Bartsch, 2019).

Finally, we are not arguing that the desire to explore does not play any role in the popularity of imaginary fictional worlds. As with any evolutionary explanations for modern behavior, both explanations (the need to belong and to explore) are speculative. However, experimental evidence demonstrates that people are more drawn to stories when they are feeling lonely and that stories help them to feel more connected (for a review, see Gabriel, Valenti, & Young, 2016). Experimental evidence for the need for exploration hypothesis suggests that both motivations explain the appeal of narratives containing imaginary worlds. In fiction as in the real world, people may love to travel to new places, but they also want to find places where they belong.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental of human motivation. *Psychological Bulletin*, *117*, 497–529.
Caporael, L. R., & Brewer, M. B. (1995). Hierarchical evolutionary theory: There is an alternative, and it's not creationism. *Psychological Inquiry*, *6*, 31–34.
Cohen, S., & Willis, T. A. (1985).Stress, social support, and the buffering hypothesis. *Psychological Bulletin*, *98*, 310–357.
Derrick, J. L., Gabriel, S., & Tippin, B. (2008). Parasocial relationships and self-discrepancies: Faux relationships have benefits for low self-esteem individuals. *Personal Relationships*, *15*, 261–280.
Ellemers, N., De Gilder, D., & Haslam, S. A. (2004). Motivating individuals and groups at work: A social identity perspective on leadership and group performance. *Academy of Management Review*, *29*, 459–478.
Frith, C. D., & Frith, U. (2006). The neural basis of mentalizing. *Neuron*, *50*(4), 531–534.
Gabriel, S., Valenti, J., & Young, A. F. (2016). Social surrogates, social motivations, and everyday activities: The case for a strong, subtle, and sneaky social self. In *Advances in experimental social psychology* (Vol. 53, pp. 189–243). Academic Press.
Gabriel, S., Valenti, J., Naragon-Gainey, K., & Young, A. F. (2017) The psychological importance of going to concerts, churches, and football games: Development and validation of the tendency for effervescent assembly measure (TEAM). *Psychological Assessment*. *29*(11), 1349–1362.
Gabriel, S., & Young, A. F. (2011). Becoming a vampire without being bitten: The narrative collective-assimilation hypothesis. *Psychological Science*, *22*(8), 990–994.
Green, M. C. (2004). Transportation into narrative worlds: The role of prior knowledge and perceived realism. *Discourse Processes*, *38*(2), 247–266.
Green, M. C., & Brock, T. C. (2000). The role of transportation in the persuasiveness of public narratives. *Journal of Personality and Social Psychology*, *79*(5), 701–721.
Haslam, S. A., O'Brien, A., Jetten, J., Vormedal, K., & Penna, S. (2005). Taking the strain: Social identity, social support, and the experience of stress. *British Journal of Social Psychology*, *44*, 355–370.
Mar, R. A., & Oatley, K. (2008). The function of fiction is the abstraction and simulation of social experience. *Perspectives on Psychological Science*, *3*(3), 173–192.
Ministero, L. M., Green, M. C., Gabriel, S., & Valenti, J. (2022). Back where I belong: Rereading as a risk-free pathway to social connection. *Psychology of Aesthetics, Creativity, and the Arts*, *16*(1), 97–109. https://doi.org/10.1037/aca0000375.
Paravati, E., Naidu, E., & Gabriel, S. (2021). From "love actually" to love, actually: The sociometer takes every kind of fuel. *Self and Identity*, *20*(1), 6–24.
Stevens, L. E., & Fiske, S. T. (1995). Motivation and cognition in social life: A social survival perspective. *Social Cognition*, *13*, 189–214.
Tajfel, H. (1970). Experiments in intergroup discrimination. *Scientific American*, *223*, 96–102.
Vinney, C., Dill-Shackleford, K. E., Plante, C. N., & Bartsch, A. (2019). Development and validation of a measure of popular media fan identity and its relationship to well-being. *Psychology of Popular Media Culture*, *8*(3), 296–307.
Wilson, E. O. (1978). *On human nature*. Harvard University Press.

Imaginary worlds are *awesome*: Awe provides a key to understanding the individual and social functions of imaginary worlds

Sean P. Goldy and Paul K. Piff

Department of Psychological Science, University of California, Irvine, Irvine, CA 92697-7085, USA
sgoldy@uci.edu
ppiff@uci.edu
https://paulpiff.wixsite.com/meshlab

doi:10.1017/S0140525X21002260, e284

Abstract

Awe arises when one experiences something so extraordinary that it defies current understanding, prompting efforts to comprehend the initially incomprehensible. We situate awe within

Dubourg and Baumard's framework for the prevalence and psychological underpinnings of imaginary worlds. We argue that imaginary worlds are powerful catalysts of awe, which, in turn, drive important individual and social outcomes.

What do the physics-defying spells of *Harry Potter*, the unprecedented scientific advances of *Star Trek*, and the superpowers embodied by the superheroes of *The Avengers* have in common? They are awe-inspiring. Experiences of awe are arguably among the most sought-after and transformative experiences in human life, and they play a pivotal role in the stories we cherish and share with others (Berger & Milkman, 2012). Awe arises when people experience something so vast, powerful, or complex that it defies their current knowledge schema and ways of seeing the world, motivating them to update their default modes of thinking to assimilate what is being experienced (Keltner & Haidt, 2003). In recent years, a scientific inquiry of awe has emerged documenting that awe causes people to seek connections with others and acquire new knowledge (Stellar et al., 2017; Valdesolo, 2021; Valdesolo, Shtulman, & Baron, 2017). From this perspective, awe is a potent impetus for exploration, sparking individuals' curiosity and shifting attention toward entities more powerful than the self.

Dubourg and Baumard (D&B) propose that imaginary worlds co-opt human preferences for exploration, explaining the prevalence, content, form, and spread of fictions that incorporate such worlds. They propose humans are drawn to the expansive, uncharted imaginary worlds of fiction for the same reasons they are captivated by new environments in real life: exploration offers rewarding opportunities to find new resources (e.g., food, mates), serving an adaptive purpose. This framework provides a foundation for a robust scientific inquiry into the psychology of imaginary worlds for years to come.

What remains a mystery in their analysis, though, is the role of emotion in imaginary worlds. Emotions are central to the experience of literary narrative fiction (Oatley, 1999). As such, an understanding of the emotions imaginary worlds evoke can attune us to the social functions these worlds serve. In our commentary, we extend the framework of D&B to examine how awe – an emotion of which imaginary worlds are powerful triggers – can enhance the psychological understanding of imaginary worlds.

Awe involves two central appraisals: a sense of vastness and a need for cognitive accommodation (Keltner & Haidt, 2003), both of which are common to the experience of imaginary worlds. Vastness refers to a stimulus that is large in physical, social, or conceptual size, whereas accommodation concerns a need to update one's current mental schema to understand the stimuli. These appraisals set the stage for the social-cognitive effects of awe documented in research. By evoking a diminished sense of self vis-à-vis something vast, awe can lead to increased humility (Stellar et al., 2018), enhanced prosocial behavior (Piff, Dietze, Feinberg, Stancato, & Keltner, 2015), greater collective engagement (Bai et al., 2017), and reduced stress (Bai et al., 2021; Shiota, Keltner, & Mossman, 2007). By requiring accommodation, awe can increase awareness of gaps in one's knowledge (McPhetres, 2019), and it is associated with openness to fresh perspectives, seeking out new experiences, and curiosity about novel information (Anderson, Dixson, Monroy, & Keltner, 2020).

We propose that awe is important to understanding the prevalence, proliferation, and psychological functions of imaginary worlds. First, imaginary worlds' qualities make them powerful sources of awe. Imaginary worlds feature novel information about a fictional environment, which often includes larger-than-life characters, striking locales, insurmountable odds, and mind-blowing concepts. Such extraordinary features allow individuals to perceive something larger than the self that defies expectations. Following this reasoning, imaginary worlds that evoke a sense of vastness and a need for cognitive accommodation should be potent catalysts of experiences of awe.

Second, awe's connection to knowledge seeking suggests that awe-inspiring imaginary worlds may powerfully pique people's curiosity. By highlighting gaps in individuals' understanding, imaginary worlds may compel individuals to seek out novel experiences and learn new information, both in the imaginary world and, possibly by extension, in the real world. Thus, given D&B's reasoning that imaginary worlds should generate more and more texts with world-building information, these texts should be particularly prevalent among awe-inspiring imaginary worlds, as people strive to absorb more about the fictions that elicited awe for them. Similarly, research also indicates that awe can spark greater interest in science (McPhetres, 2019), suggesting that awe-inspiring science fiction might lead to enhanced engagement with scientific modes of knowledge acquisition and pursuit.

Third, given that awe and awe-related experiences shift focus away from day-to-day concerns and stressors (Bai et al., 2021; Joye, Bolderdijk, Köster, & Piff, 2020; Shiota et al., 2007; Zhang, Piff, Iyer, Koleva, & Keltner, 2014), imaginary worlds may be potent sources of stress-reduction, enhancing happiness and well-being. As conduits of awe, imaginary worlds offer individuals the chance to immerse themselves in a fictional environment detached from their everyday stresses and concerns, reorienting attention away from the self and its worries to the immersive, novel features of the fictional milieu. Accordingly, immersing oneself in an awe-inspiring imaginary world may be a helpful strategy for coping with stress, and individuals who engage with these worlds may lead less stressful and happier lives.

Finally, given that awe promotes virality (Berger & Milkman, 2012) and enhances social connection (Bai et al., 2017; Goldy & Piff, 2020; Piff et al., 2015), imaginary worlds may be powerful motivators of collective life – as evidenced by the expansive close-knit communities observed among fans of imaginary worlds across the globe. As an emotion that sparks sharing and helps individuals fold into cohesive collectives (Stellar et al., 2017), awe aroused by imaginary worlds may help explain why these gatherings exist and prosper, binding individuals together in their collective awe of their favorite stories, characters, and contexts.

Our conceptual analysis and empirical review underscore that awe may be central to our understanding of imaginary worlds' popularity and shape, and they point to exciting lines of inquiry into the possible individual and social benefits of imaginary worlds. By sparking curiosity, diminishing self-focus, and heightening awareness of entities larger than oneself, imaginary worlds may compel individuals to learn, seek out novelty, and reduce everyday stress, all while connecting with others along the way.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Anderson, C. L., Dixson, D. D., Monroy, M., & Keltner, D. (2020). Are awe-prone people more curious? The relationship between dispositional awe, curiosity, and academic outcomes. *Journal of Personality*, *88*(4), 762–779. https://doi.org/10.1111/jopy.12524.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Bai, Y., Maruskin, L. A., Chen, S., Gordon, A. M., Stellar, J. E., McNeil, G. D., … Keltner, D. (2017). Awe, the diminished self, and collective engagement: Universals and cultural variations in the small self. *Journal of Personality and Social Psychology*, *113* (2), 185–209. https://doi.org/10.1037/pspa0000087.

Bai, Y., Ocampo, J., Jin, G., Chen, S., Benet-Martinez, V., Monroy, M., … Keltner, D. (2021). Awe, daily stress, and elevated life satisfaction. *Journal of Personality and Social Psychology*, *120*(4), 837–860. https://doi.org/10.1037/pspa0000267.

Berger, J., & Milkman, K. L. (2012). What makes online content viral? *Journal of Marketing Research*, *49*(2), 192–205. https://doi.org/10.1509/jmr.10.0353.

Goldy, S. P., & Piff, P. K. (2020). Toward a social ecology of prosociality: Why, when, and where nature enhances social connection. *Current Opinion in Psychology*, *32*, 27–31. https://doi.org/10.1016/j.copsyc.2019.06.016.

Joye, Y., Bolderdijk, J. W., Köster, M. A. F., & Piff, P. K. (2020). A diminishment of desire: Exposure to nature relative to urban environments dampens materialism. *Urban Forestry & Urban Greening*, *54*, 126783. https://doi.org/10.1016/j.ufug.2020.126783.

Keltner, D., & Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition and Emotion*, *17*(2), 297–314. https://doi.org/10.1080/02699930302297.

McPhetres, J. (2019). Oh, the things you don't know: Awe promotes awareness of knowledge gaps and science interest. *Cognition and Emotion*, *33*(8), 1599–1615. https://doi.org/10.1080/02699931.2019.1585331.

Piff, P. K., Dietze, P., Feinberg, M., Stancato, D. M., & Keltner, D. (2015). Awe, the small self, and prosocial behavior. *Journal of Personality and Social Psychology*, *108*(6), 883–899. https://doi.org/10.1037/pspi0000018.

Oatley, K. (1999). Why fiction may be twice as true as fact: Fiction as cognitive and emotional simulation. *Review of General Psychology*, *3*(2), 101–117. https://doi.org/10.1037/1089-2680.3.2.101.

Shiota, M. N., Keltner, D., & Mossman, A. (2007). The nature of awe: Elicitors, appraisals, and effects on self-concept. *Cognition and Emotion*, *21*(5), 944–963. https://doi.org/10.1080/02699930600923668.

Stellar, J. E., Gordon, A., Anderson, C. L., Piff, P. K., McNeil, G. D., & Keltner, D. (2018). Awe and humility. *Journal of Personality and Social Psychology*, *114*(2), 258–269. http://dx.doi.org/10.1037/pspi0000109.

Stellar, J. E., Gordon, A. M., Piff, P. K., Cordaro, D., Anderson, C. L., Bai, Y., … Keltner, D. (2017). Self-transcendent emotions and their social functions: Compassion, gratitude, and awe bind us to others through prosociality. *Emotion Review*, *9*(3), 200–207. http://dx.doi.org/10.1177/1754073916684557.

Valdesolo, P. (2021). Stop making sense? *Annals of the New York Academy of Sciences*, *1501*(1), 75–77. https://doi.org/10.1111/nyas.14570.

Valdesolo, P., Shtulman, A., & Baron, A. S. (2017). Science is awe-some: The emotional antecedents of science learning. *Emotion Review*, *9*(3), 215–221. https://doi.org/10.1177/1754073916673212.

Zhang, J. W., Piff, P. K., Iyer, R., Koleva, S., & Keltner, D. (2014). An occasion for unselfing: Beautiful nature leads to prosociality. *Journal of Environmental Psychology*, *37*, 61–72. https://doi.org/10.1016/j.jenvp.2013.11.008.

Simulation, stories, and fictional worlds

Patrick Colm Hogan

Department of English, University of Connecticut, Storrs, CT 06269-4025, USA
Patrick.hogan@uconn.edu; https://english.uconn.edu/person/patrick-hogan/

doi:10.1017/S0140525X21002107, e285

Abstract

The authors explain our attraction to strange, literary places as resulting from our attraction to strange places in real life. I believe this is correct and important. The aim of the following commentary is to show that their main conclusion is closely related to – even (retrospectively) predictable from – the operation of simulation and the consequences of that operation for storytelling.

In *How Authors' Minds Make Stories* (Hogan, 2013) and elsewhere (Hogan, 2017; Hogan, forthcoming), I have argued that, for simulation to fulfill its adaptive functions, it requires some specifiable properties, not all of which are consistently recognized. I take simulation to be (roughly) the mental generation of a particular causal sequence that is, so to speak, semi-perceptual and pseudo-motor. By *semi-perceptual and pseudo-motor*, I mean that the neural processes underlying simulation overlap significantly with full perceptual experience and/or bodily action. This semi-perceptual and pseudo-motor quality is usually spoken of today in terms of *embodiment* (see Wojciehowski & Gallese, forthcoming). Much recent research suggests that large areas of cognitive and affective processing are at least in part embodied. For example, semantic representations (meanings) of many, perhaps all words are semi-perceptual and/or pseudo-motor. Thus, the meaning of "grasp" is not a combination of abstract semantic primitives, but rather a set of cortical activations related to actions of grasping with one's hands (see Pulvermüller & Fadiga, 2010, p. 355). As semi-perceptual and pseudo-motor, simulation too is, in part, an embodied process. Given the continuity between simulation and semantic meaning, it is unsurprising that simulation is often guided by words, particularly in literature (an idea broadly consistent with Scarry's [1999] observations about literary imagination). On the other hand, simulation is by no means always literary.

The main (adaptive) function of simulation would appear to be the identification of threats and opportunities, removed from the risks associated with real action. For example, Glug imagines trying to wrest a tasty-looking fruit from Mutt, but after briefly envisioning a battle with his behemoth-like antagonist, he refrains. The risk of acting without awareness of threats is obvious. The risk associated with opportunities would be the "opportunity costs" (in the economic sense) incurred by ignoring potentially more advantageous alternatives. The minimization of dangers and of opportunity costs suggests the value of parametric variations – systematically imagined alternatives – in our simulations regarding physical and social conditions and regarding our own behavior in those conditions.

The preceding comments concern the representational component of simulation, defined by our imagination of different possible circumstances and different possible responses to those circumstances. But representation is not sufficient for simulation to have adaptive benefits. Simulation must activate motivation systems. I may imagine some sequence of events, but this does not mean I will act on that imagination. For example, suppose I know about Glug and Mutt. Unless I have some emotional engagement with their situation, I am unlikely to do anything to forestall Glug's (potentially suicidal) decision to challenge Mutt. Most obviously, I might experience empathic fear (fear for Mutt – perhaps fear that I believe Mutt should be feeling, even if he is not actually feeling it). The same, empathic point applies to myself in the future, as I simulate how outcomes of my actions will affect me (a relation between empathy and prudence is indicated by, e.g., work on the temporoparietal junction; see Soutschek et al., 2016 [see also Yong 2016]). Having self-empathy means that I feel some version of what I would feel were I actually in the simulated circumstances.

There are various complications here, particularly regarding the intensity of the emotional response, which I will leave aside. However, one complication is important in the present context. Aversive emotional responses to simulated dangers could lead us to avoid simulating potentially threatening experiences, which would largely undermine the benefits of simulation. However, there is evidence that compassionate empathic responses involve the reward system, including dopamine pathways (see Kim et al.,

2009, p. 2079), thus what Panksepp (1998) calls the SEEKING system. This reward system involvement, then, promotes engagement with the target's experience – thus, continued simulation – even if this is aversive.

The results for our experience of fictional narrative are straightforward. In *The Mind and Its Stories* (Hogan, 2003), I isolate several cross-culturally recurring story genres. The structure of any genre is, roughly, as follows: An emotion system or set of emotion systems establishes a goal for a main character or characters. This goal may result from a concern for individual or in-group pride, romantic love (a combination of attachment bonding and sexual desire), or other emotion systems. The main characters face the risk of being irrevocably deprived of their goal (e.g., in heroic tragi-comedy, the [in-group] nation appears to be humiliated by the domination of an enemy). However, they manage to reverse the situation and succeed (often establishing even greater glory for the [in-group] nation than formerly). The reader empathizes with the main characters based on his or her own experience of parallel goals (e.g., advancing in-group status) and his or her (embodied) simulation of those characters' (fictional) actions and experiences. Thus, one's engagement with fictional narratives derives principally from one's real-life motivations as these are activated and guided in empathic simulation.

This returns us to the topic of Dubourg and Baumard's (D&B) article. In *How Authors' Minds Make Stories* (2013), I contend that authors produce stories in part by integrating story prototypes (e.g., heroic tragi-comedy) with particular, simulated characters and settings. In earlier work, I paid little attention to settings. However, given the cross-cultural recurrence of quest motifs, with their frequent focus on setting, the preceding analyses would lead us to expect that the same sort of process would explain our engagement with exploring fictional worlds (thus settings). In this case, though, the motivational impetus would be provided by *seeking*, rather than, say, in-group pride. This is precisely what D&B show.

My aim in these comments has been to support D&B's main argument, but to do so by approaching the topic from a different angle. Specifically, I have tried to outline a general account of simulation and fiction that in effect (retrospectively) predicts their main conclusion. Put differently, I hope to have shown that D&B's treatment of imaginary worlds and the work just outlined on simulation and story universals are ultimately parts of a shared research program. Recognition of this commonality should prove mutually enriching, and aid further study and theorization.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Hogan, P. (2003). *The mind and its stories: Narrative universals and human emotion*. Cambridge University Press.

Hogan, P. (2013). *How authors' minds make stories*. Cambridge University Press.

Hogan, P. (2017). The paradox of tragedy and emotional response to simulation. *Behavioral and Brain Sciences*, *40*, 31–32.

Hogan, P. (forthcoming). Paradoxes of literary emotion: Simulation and The Zhào Orphan. In P. Hogan, B. Irish & L. Hogan (Eds.), *Routledge companion to literature and emotion* (pp. 134–143). Routledge.

Kim, J.-W., Kim, S.-E., Kim, J.-J., Jeong, B., Park, C.-H., Son, A., … Ki, S. (2009). Compassionate attitude toward others' suffering activates the mesolimbic neural system. *Neuropsychologia*, *47*, 2073–2081.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions*. Oxford University Press.

Pulvermüller, F., & Fadiga, L. (2010). Active perception: Sensorimotor circuits as a cortical basis for language. *Nature Reviews: Neuroscience*, *11*(5), 351–360.

Scarry, E. (1999). *Dreaming by the book*. Farrar, Straus, Giroux.

Soutschek, A., Ruff, C., Strombach, T., Kalenscher, T., & Tobler, P. (2016). Brain stimulation reveals crucial role of overcoming self-centeredness in self-control. *Science Advances*, *2*(10), 1–8. https://advances.sciencemag.org/content/2/10/e1600992

Wojciehowski, H., & Gallese, V. (forthcoming). Embodiment: Embodied simulation and emotional engagement with fictional characters. In P. Hogan, B. Irish & L. Hogan (Eds.), *The Routledge companion to literature and emotion* (pp. 61–73). Routledge.

Yong, E. (2016). Self-control is just empathy with your future self. *The Atlantic*. https://www.theatlantic.com/science/archive/2016/12/self-control-is-just-empathy-with-a-future-you/509726/.

Middle-earth wasn't built in a day: How do we explain the costs of creating a world?

Aaron D. Lightner[a,b], Cynthiann Heckelsmiller[b] and Edward H. Hagen[b]

[a]Department of the Study of Religion, Aarhus University, 8000 Aarhus, Denmark and [b]Department of Anthropology, Washington State University, Pullman, WA 99164-4910, USA

adlightner@cas.au.dk, c.heckelsmiller@wsu.edu, edhagen@wsu.edu

doi:10.1017/S0140525X21002296, e286

Abstract

Dubourg and Baumard explain why fictional worlds are attractive to consumers. A complete account of fictional worlds, however, should also explain why some people *create* them. Creation is a costly and time-consuming process that does not resemble exploration but does resemble the culturally universal phenomenon of knowledge specialization.

> I hate writing; I love having written.
> *Dorothy Parker*

In an interview, British actor Simon Jones recalled the struggle for his personal friend Douglas Adams to finish creating *Hitchhiker's Guide to the Galaxy*:

> He labored over his sentences in Hitchhiker's Guide. In fact, Douglas was a victim of his own perfectionism because it was agony for him to write. It took him forever…Douglas used to take long baths or find all sorts of excuses to not do it (Larkin, 2020).

Many writers similarly toil for years to realize their fictional worlds as a finished product. Indeed, worldbuilding is enormously complex and difficult. In addition to pulling readers into a compelling narrative, writers must maintain consistency in describing their fictional worlds, considering aspects like spatial and temporal scales, social relationships, and readers' expectations about behavior and dialogue among characters. They have to supply the reader with details, often bundled into narratives, that are not distracting, overly counterintuitive, or otherwise burdensome. The worldbuilder's task is not to simply imagine possibilities, but to narrow a vast possibility space into concrete, readable

narratives that hang together in a coherent and (at least somewhat) believable way.

Worldbuilding therefore demands creative writing skills that, like many other skills, are developed with years of deliberate practice (Ericsson, 2006). Because mainstream success is extremely unlikely, the years of writing and editing multiple drafts is also an enormous opportunity cost. Why, then, did Tolkien spend most of his life perfecting his piecemeal stories about Middle-earth (Carpenter, 2000), ultimately for the enjoyment of other readers? Why did J. K. Rowling, as an unemployed and impoverished single parent (Kirk, 2003), work tirelessly to finish her early manuscripts of *Harry Potter*?

Dubourg and Baumard (D&B) explain why consumers enjoy fictional worlds, but in our view they do not explain the motivation to create these worlds. The arduous task of worldbuilding, a process typically taken on by heavily invested *creators*, does not resemble exploring the finished product, contrary to D&B's brief claim that creators are "best seen as curious explorers" (target article, sect. 7). Creators skillfully use intense, attention-grabbing stimuli (target article, sect. 3), but why go to such effort to stimulate readers in the first place? What incentives drive some individuals to take on the costs of building a fictional world?

To explain the motivation and skills of content creators, we propose a different set of selection pressures and evolved psychological mechanisms. *Knowledge specialists*, who similarly invest their life's work in cultivating high levels of expertise in some domain (e.g., medicine, astronomy), appear in nearly all known cultures. Like worldbuilders, these specialists agonize over mastering their skills and services. Like the audience of consumers who enjoy fictional worlds, non-specialists can and do benefit from specialists' expertise (Lightner, Heckelsmiller, & Hagen, 2021a).

Specialists often treat their knowledge as they would any other economic resource in a market setting. If their knowledge has value based on its scarcity (e.g., healers making a living providing treatments to their clientele), then they tend to keep it secretive and proprietary (Lewis, 2015). If a specialist has exceptional skill in a domain that is widely used (e.g., hunting, cooking), then the specialist might share their knowledge with others in exchange for prestige (Henrich & Gil-White, 2001). Both types of specialists are widespread across cultures (Lightner, Heckelsmiller, & Hagen, 2021b).

This is useful because, if we want to develop a theory that explains "this urge to *create* new fictional locations from scratch" (target article, sect. 2, emphasis ours), then we might consider how and why creators, like knowledge specialists, stand to benefit from their costly investments. The intellectual property rights to popular fictional worlds are often lucrative, and are therefore proprietary and closely guarded by their original creators. Fan fiction writers and video game modders routinely expand these publicly available worlds, and while modders, for example, might be driven by curiosity (target article, sect. 7), it is hard to see why they would share their creations – often providing documentation and resolving bug reports – without some kind of prestige or financial incentive.

The reality, of course, is far less dichotomous than individual creators versus population-level revisionists, as our sketch here might suggest. Knowledge specialists frequently collaborate in mutually beneficial distributions of cognitive labor (Keil, 2003; Mercier & Heintz, 2014), even when their knowledge is proprietary (Lightner et al., 2021b). Similarly, worldbuilders who work tirelessly to create intellectual property worth defending do not do so in a vacuum. The foundational myths, folklore, and contemporary works that inspire fictional worlds can make worldbuilding resemble a widely distributed population-level process, reducing the burden on an individual creator in many cases. This is especially true when a large bulk of a fictional world is supplied by existing cultural information, such as religions (e.g., in allegorical tales such as Dante's *Inferno* or C. S. Lewis' *Narnia*). Worldbuilders also outsource tasks to leverage the creativity and skill of a larger crowd. George Lucas, for example, seeded the initial story of *Star Wars* with "Annikin Starkiller," but years of outsourced rewrites and edits shaped the final version of Luke Skywalker (Rinzler, 2007). Even open source modding communities depend on the video game firms who enable modifications and benefit from increasing the long-term appeal of their games (Lee, Lin, Bezemer, & Hassan, 2020; Yang, 2018).

D&B do a commendable job of explaining why, from an evolutionary perspective, fictional worlds are attractive. We doubt that their account fully explains the "drive to create new cultural content without any direct return on investment" (target article, sect. 7.2, para. 1), however, because creating a fictional world requires considerable effort and incurs substantial opportunity costs but has a low probability of financial success. Conan Doyle could have remained a surgeon, Vonnegut made a prosperous enough living as a Saab dealer, and Tolkien would have had a thriving career as an academic philologist, translator, and codebreaker. An evolutionary account of fictional worlds should consider the material costs and incentives to the creators, and a useful starting point will be to consider how their commitments reflect those made by knowledge specialists, across cultures and human history, to benefit others (Lightner et al., 2021a, 2021b).

Funding. This work was supported by the Issachar Fund and Templeton Religion Trust (ADL, EHH); and the Aarhus University Research Foundation (ADL).

Conflict of interest. None.

References

Carpenter, H. (2000). *J.R.R. Tolkien: A biography* (1st ed.), Houghton Mifflin Company.

Ericsson, K. A. (2006). The influence of experience and deliberate practice on the development of superior expert performance. In K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 683–703). Cambridge University Press. https://doi.org/10.1017/CBO9780511816796.038

Henrich, J., & Gil-White, F. J. (2001). The evolution of prestige: Freely conferred deference as a mechanism for enhancing the benefits of cultural transmission. *Evolution and Human Behavior*, *22*(3), 165–196.

Keil, F. C. (2003). Folkscience: Coarse interpretations of a complex reality. *Trends in Cognitive Sciences*, *7*(8), 368–373. Publisher: Elsevier.

Kirk, C. A. (2003). *J. K. Rowling: A biography*. Greenwood Publishing Group.

Larkin, A. (2020). Right Ho, Jeeves (with bonus material) by P.G. Wodehouse, narrated by Simon Jones.

Lee, D., Lin, D., Bezemer, C.-P., & Hassan, A. E. (2020). Building the perfect game – an empirical study of game modifications. *Empirical Software Engineering*, *25*(4), 2485–2518.

Lewis, J. (2015). Where goods are free but knowledge costs. *Hunter Gatherer Research*, *1* (1), 1–28.

Lightner, A., Heckelsmiller, C., & Hagen, E. (2021a). Ethnomedical specialists and their supernatural theories of disease. *Review of Philosophy and Psychology*. https://doi.org/10.1007/s13164-021-00589-8.

Lightner, A. D., Heckelsmiller, C., & Hagen, E. H. (2021b). Ethnoscientific expertise and knowledge specialisation in 55 traditional cultures. *Evolutionary Human Sciences*, *3*, e37. doi:10.1017/ehs.2021.31.

Mercier, H., & Heintz, C. (2014). Scientists' argumentative reasoning. *Topoi*, *33*(2), 513–524. Publisher: Springer.

Rinzler, J. W. (2007). *The making of Star Wars: The definitive story behind the original film*. Del Rey, New York, illustrated edition.

Yang, F. (2018). Crowdsourcing distribution on software market. 1–27. *Unpublished Manuscript*.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

"Never Land": Where do imaginary worlds come from?

Sue Llewellyn

Faculty of Humanities, University of Manchester, Manchester M13 9PL, UK
sue.llewellyn@manchester.ac.uk
https://www.research.manchester.ac.uk/portal/en/researchers/susan-llewellyn(935188b6-d869-4122-bfce-be3d1bd72c9c).html

doi:10.1017/S0140525X21002302, e287

Abstract

We assume "Imaginary worlds" to be unreal and unfamiliar: high fantasy. I argue they are real and familiar to authors because they comprise memory elements, which blend experience, knowledge, beliefs and pre-occupations. These "bits and pieces" from memories can generate a world, which readers experience as pure imagination. I illustrate using J.M. Barrie's "Never Land" and J.R.R. Tolkien's "Middle-Earth."

The authors do not define "Imaginary worlds," implicitly assuming they are unreal and unfamiliar: high fantasy. Commenting on the psychological foundations of imaginary worlds, I contend they are real and familiar to their author – in the sense that they come from memory elements, which blend experience, knowledge, beliefs and pre-occupations. I argue authors take these fragments out of their real-life time and place context. They, then, creatively associate them, extending their possibilities and reach into new times and places. The strange and unfamiliar juxtaposition and extension of these "bits and pieces" from an author's memories can generate a world, which readers experience as pure imagination. To illustrate, I use J.M. Barrie's "Never Land" and J.R.R. Tolkien's "Middle-Earth."

When James Barrie was 6, his gifted and handsome elder brother, David, died in a skating accident; the idea that his "lost" sibling would never grow up, would stay a perfect boy forever, fascinated, captivated and disturbed him (Lane, 2014). Barrie's character "Peter Pan," as may be expected, for a boy who would *never* grow up, flies off to Never Land – from his home in Kensington Gardens (Barrie, 1928). The origins of Peter Pan lie in the five Llewelyn-Davies brothers whom Barrie met in Kensington Gardens; they became "lost" when both their parents died in early adulthood (Chaney, 2006). In his Dedication to "To the five" in Peter Pan, Barrie writes, "I suppose I always knew that I made Peter by rubbing the five of you violently together. That is all Peter is- the spark I got from you" (Birkin, 2003). On Never Land, an island with a lagoon, this associative, composite Peter Pan, meets the "Lost Boys," along with fairies, pirates, Native Americans, mermaids and wild animals, including a crocodile. During many summers, Barrie spent every day with Llewelyn-Davies boys, as the evil pirate Captain Swarthy, he involved them in heroic adventures around a lake, fighting pirates and rescuing those captured by them, whilst evading dangerous beasts (Dudgeon, 2008).

As shown here, Barrie's Never Land takes memory fragments out of their time and place context and associates them (or in Barrie's words "rubs them together") to create an imaginary world. Never Land does not replay Barrie's experiences. For example, there is no Captain Swarthy, rather a Captain Hook appears, Barrie's local postman had a hook instead of right hand. Arguably, Barrie's pre-occupation with the boy who never grew up, reflecting his brother's death, was the vital creative drive for Never Land but also, Barrie himself never fully participated in the adult world (Chaney, 2006). He too often inhabited a child-like Never Land.

The places in Tolkien's imaginary world, "Middle-earth" came, in part, from his early formative experiences at Sarehole (historically in Worcestershire), and, later as a teenager, in the Swiss Alps. Tolkien commented that "The Shire" in Middle-earth was "inspired by a few cherished square miles of actual countryside at Sarehole" (Jahangir, 2014). Bilbo Baggins, a "hobbit" character, lives at Bag End, named for the farm of Tolkien's aunt; his journey across the misty mountains echoed Tolkien's own teenage Alpine trek (Carpenter, 2014). As a Professor of Anglo-Saxon (Old English) at Oxford, Tolkien's academic knowledge was influential. The term, Middle-earth, originated in the Old English word, Midgard, the "habitable lands of men" (Martinez, 2013). Tolkien's Catholic beliefs pervaded his lived experience, but he wrote that Middle-earth was "a monotheistic world of 'natural theology'," implying it expressed "beauty and wonder and even holiness" rather than explicitly Christian teachings (Madsen, 1988). Tolkien drew on Old Norse mythology. For example, in both *The Hobbit* and *The Lord of the Rings*, Tolkien's immortal wizard Gandalf resembles the Norse god Odin, being a wanderer/guide, with a long white beard, wearing large, wide brimmed hat along with a cloak, and carrying a staff; Gandalf's mission, disseminating knowledge, truth and wisdom is also similar to that of Odin (Buckley, 2017). As were Tolkien's own aims, as an Oxford don (Jakobsson, 2019). Tolkien was conscious of the projection from creator to creation, writing, "I am in fact a hobbit in all but size. I like gardens, trees…I smoke a pipe and like good plain food…I go to bed late and get up late (when possible)" (Carpenter, 2014).

This is not to argue that imaginary worlds are jumbled autobiographies. Rather, like dreams, creations can surprise their creators: where did that come from? The writer may have specific intentions for an imaginary world but once underway the realm can take on a life of its own, developing in unexpected ways (Perry, 2021) through a complex nexus of associations arising from the author but not always or, perhaps even usually, under their conscious control (Llewellyn, 2020). The imaginary worlds of Barrie and Tolkien present some contrasts. In Barrie's case, the associative web of Never Land emerges largely from personal experiences and pre-occupations but knowledge and belief frequently weave the nexus of associations underlying Tolkien's Middle-earth.

Why are imaginary worlds so seductive? In answer, the authors explore their evolutionary origins, which "tap into human's preferences for exploration" (target article, sect. 7.1, para. 1) to discover "new sources of reward" (target article, abstract). I argue the roots of imaginary worlds in experience, beliefs, knowledge and pre-occupations would greatly benefit exploration because our experience of past places generates expectations, which help us first, imagine and, second, negotiate new ones. Citing Lee (1966), the authors state early humans "led a nomadic way of life." Recent research challenges this. Few animals are nomads; most occupy a home range (Powell, 2000). Early humans lived much as animals did (Harari, 2014), albeit their home range was much larger (Boisvert, 2021). Consequently, exploration to find new sources of reward within the home range would have started from familiar territory, conferring big advantages in searching for food, water and potential mates, while avoiding predators and competitors through known escape routes back to the home base (Stamps, 1995).

"Write what you know" is the most famous advice about writing "fiction." Just as it makes sense to reach into new land from

within known territory, you create a Never Land, an imaginary world, from within your experiential self.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Barrie, J. M. (1928). *Peter Pan*. Hodder and Stoughton.
Birkin, A. (2003). *J.M. Barrie and the lost boys*. Yale University Press.
Boisvert, M. (2021). Home range size. Accessed 23rd September, 2021. Available at https://carta.anthropogeny.org/moca/topics/home-range-size.
Buckley, C. (2017). *How Icelandic Norse mythology influenced Tolkien*. Available at https://theculturetrip.com/europe/iceland/articles/how-icelandic-norse-mythology-influenced-tolkien/
Carpenter, H. (2014). *JRR Tolkien*: A biography. Houghton Mifflin Harcourt.
Chaney, L. (2006). *Hide-and-seek with angels: A life of JM Barrie*. Arrow Books.
Dudgeon, P. (2008). *Captivated: JM Barrie, the du Mauriers and the dark side of Neverland*. Chatto & Windus.
Harari, Y. (2014). *Sapiens: A brief history of humankind*. Harvill Secker.
Jahangir, R. (2014). *The Hobbit: How England inspired Tolkien's Middle Earth*. Available at https://www.bbc.co.uk/news/uk-england-29787528
Jakobsson, Á. (2019). *Tolkien and his Medieval Icelandic models*, part of a talk given at the 8th Omentieva Toltea, Reykjavík, 2 Aug 2019. Available at https://www.icelandicroots.com/post/tolkien-and-his-medieval-icelandic-models
Lane, A. (2014) Why J. M. Barrie created Peter Pan: The deep wounds that inspired the beloved children's character. *The New Yorker*, November 22. Available at https://www.newyorker.com/magazine/2004/11/22/lost-boys
Lee, E. S. (1966) *A theory of migration*, 12.
Llewellyn, S. (2020). *What do dreams do?* Oxford University Press.
Madsen, C. (1988). "Light from an invisible lamp: Natural religion in *The Lord of the Rings*," *Mythlore: A journal of J.R.R. Tolkien, C.S. Lewis*, Charles Williams, and Mythopoeic Literature: Vol. 14: No. 3, Article 9. Available at https://dc.swosu.edu/mythlore/vol14/iss3/9
Martinez, M. (2013). *Is Middle-earth supposed to be Midgard*? Available at https://middle-earth.xenite.org/is-middle-earth-supposed-to-be-midgard/
Perry, S. (2021). *With a Da bin ich*! Review of: Wilson, F. (2021) *Burning Man: The Ascent of D.H. Lawrence*, Bloomsbury. *London Review of Books*, *43*(17), 23–26.
Powell, R. A. (2000). Animal home ranges and territories and home range estimators. *Research Techniques in Animal Ecology: Controversies and Consequences*, *1*, 476.
Stamps, J. (1995). Motor learning and the value of familiar space. *The American Naturalist*, *146*(1), 41–58.

The evolution of imagination and the adaptive value of imaginary worlds

Richard Moore[a] and Thomas Hills[b]

[a]Department of Philosophy, Social Sciences Building, University of Warwick, Coventry, CV4 7AL, UK and [b]Department of Psychology, University of Warwick, Coventry, CV4 7AL, UK
Richard.Moore@warwick.ac.uk;
https://warwick.ac.uk/fac/soc/philosophy/people/summaries/moore/
T.T.Hills@warwick.ac.uk;
https://warwick.ac.uk/fac/sci/psych/people/thills/

doi:10.1017/S0140525X2100217X, e288

Abstract

Characterizing the cultural evolution of imaginary worlds as a hedonic but non-adaptive exaptation from evolved exploratory tendencies, Dubourg and Baumard defend too narrow a conception of the adaptive evolution of imaginary worlds. Imagination and its imaginary worlds are ancient and adaptive, allowing deliberation over actions, consequences, and futures worth aspiring to, often engendering the world we see around us.

Our world consists of imaginings brought to life. In any city or campus, one is beset with manifested visions: buildings out of the minds of architects, seed trees planted to match groundskeepers' aesthetic anticipations, and clothes conjured by designers. Even the abstractions of scientific fields were visions before they became realities (e.g., what is "informatics"?). The economic realities in which these institutions dwell are often also the products of imagined worlds that became true because they were believed (Merton, 1948; Shiller, 2020). These are what Sarbin (1997) called believed imaginings, developing the ideas of James (1896) who wrote of the will to believe as a force that brings imaginings to life.

In contrast to Sarbin and James, Dubourg and Baumard (D&B) argue that imaginary worlds evolved out of preferences for exploration, which "propel individuals toward new environments and sources of reward" (abstract), and which subsequently "have been co-opted by cultural evolution for entertainment" (target article, sect. 7.1, para. 1). Their arguments treat imaginary worlds as a form of cognitive exploitation: Like a new drug that takes advantage of evolved reward centers without itself offering any evolutionary benefit, imaginary worlds exploit cognition while offering little practical advantage. In contrast, we argue imaginary worlds are evolutionarily ancient and satisfy a range of important needs that persist in contemporary culture.

It is useful to recognize that imaginary worlds predate modern culture. Though D&B distinguish between the non-fictional worlds of religious narratives and fictional worlds created for "pure entertainment," we find the distinction unhelpful, and likely to stall evolutionary investigation. The diverse origin and religious stories told among indigenous peoples feature rich imaginary worlds populated with fantastical characters (Hills, 2018). Many of these exist only as oral traditions, but we have ample records of Norse and Greek mythologies, as well as Sanskrit epics such as the *Ramayana*, which date back millennia. Thus, though a contemporary market has recently arisen around "fictional" imaginary worlds, the construction of imaginary worlds is much older – predating contemporary bookstores by thousands of years.

It is likely that the adaptive value of imaginary worlds, and the imagination that derives them, predates the diversification of mammals. Agents who can simulate the outcomes of actions prior to acting – what Dennett (1996) calls "Popperian agents" – have numerous adaptive advantages. These include anticipating and valuing the consequences of potential actions, conceiving of alternative futures they would lead to, and then choosing actions that would better engender those futures which are most preferred (Hills, 2019a). This is a form of self-projection, the capacity to imagine oneself in an alternate future or counterfactual environment, which is adaptive and, despite previous claims (Suddendorf & Corballis, 2007), is seen not only in humans. Electrical recordings from hippocampal place cells – active when animals are in specific locations – demonstrate that rats are capable of imagining routes they've never taken (Pezzulo, van der Meer, Lansink, & Pennartz, 2014). These sources of inner navigation, what Tolman (1948) called "cognitive maps," are increasingly observed in other vertebrates (e.g., Eliav et al., 2021; Ranc, Moorcroft, Ossi, & Cagnacci, 2021). What these adaptive and comparative biological details tell us is that the capacity to imagine novel experiences is both adaptive and evolutionarily old.

Not only are imagined worlds ancient; they also satisfy values beyond cognitive wanderlust, for example, as methods for constructing goals and evaluating actions. To deliberately plant an oak that will live for 1000 years is, minimally, to envisage a future

in which that oak thrives. We also engage these imaginary worlds in our own generative self-construction, to determine what we will become (Hills, 2019a). Following Darwin, we see imaginary worlds not as a special kind of modern cognitive construction, but as differing by degrees from the imaginings of our non-human ancestors.

As D&B rightly point out, there is still much to account for in the ongoing cultural evolution of imaginary worlds. Yet it is worth considering to what extent these imaginary worlds are functionally homologous with the ancestral imaginary cognitions that have given rise to them, or have become exaptations, functionally independent of their origins, now evolving in response to additional features of cognitive or cultural selection (e.g., Hills, 2019b). The literature of imaginary worlds – from folk tales to space operas – would seem to reflect many adaptive values that would be familiar to our ancestors.

Fantasy worlds vary widely but typically provide settings for common themes of existential conflict, reward seeking, and moral and political parables. Thus, imagined worlds can be used as vehicles for instruction, counterfactual reasoning, and future exploration (e.g., Irwin, 2019; Read & Hills, 2021), just as they might to different degrees in children or other animals. Contemporary sci-fi and fantasy elaborate on persistent evolutionary themes, containing not just vivid descriptions of imagined ecologies but almost always actors who are faced with economic, reproductive, and social (e.g., moral and political) challenges. These actors represent persons somewhat like us, even when they are non-human (e.g., *The Fantastic Mr. Fox* and *District 9*). Their challenges are often made more salient by the altered environments they inhabit. Ian McDonald's *Luna* trilogy, for example, contains rich and vivid descriptions of the hostile lunar climate: "*The moon has a thousand ways to kill you*." This environment is not an end in itself. It is used as a foundation for conceiving of a society in which capitalism has been pushed to extremes, where breathing costs money, and where there are no laws, only negotiations. Thus, the imaginary world of the moon is used as a foundation for asking and answering questions about how we should live in the real world. Often these imagined adventures explore real-world conflicts: the central conflict between the Alliance and the Browncoats in *Firefly* was inspired by Michael Shaara's civil war book, *The Killer Angels*.

In sum, imagination and the imaginary worlds it engenders are ancient and adaptive, allowing deliberation over actions and their consequences, the evaluation of futures worth aspiring to, and rendering future challenges more salient. In many cases, they give rise to the world we see around us.

Funding statement. Richard Moore is supported by a UKRI Future Leaders Fellowship grant. Thomas Hills is supported by the Royal Society Wolfson Research Merit Award (WM160074) and the Alan Turing Institute.

Conflict of interest. None.

References

Dennett, D. (1996) *Darwin's dangerous idea*. Simon & Schuster.
Eliav, T., Maimon, S. R., Aljadeff, J., Tsodyks, M., Ginosar, G., Las, L., & Ulanovsky, N. (2021). Multiscale representation of very large environments in the hippocampus of flying bats. *Science*, *372*(6545), eabg4020, 1–12.
Hills, T. T. (2018). Masters of reality: Why did shamanism evolve around the globe? *Aeon*.
Hills, T. T. (2019a). Neurocognitive free will. *Proceedings of the Royal Society B*, *286* (1908), 20190510.
Hills, T. T. (2019b). The dark side of information proliferation. *Perspectives on Psychological Science*, *14*(3), 323–330.
Irwin, W. (2019). *Black mirror and philosophy: Dark reflections*. John Wiley & Sons.
James, W. (1896). The will to believe. *The New World*, *5*, 327–347.
Merton, R. K. (1948). The self-fulfilling prophecy. *The Antioch Review*, *8*(2), 193–210.
Pezzulo, G., van der Meer, M. A., Lansink, C. S., & Pennartz, C. M. (2014). Internally generated sequences in learning and executing goal-directed behavior. *Trends in Cognitive Science 18*, 647–657.
Ranc, N., Moorcroft, P. R., Ossi, F., & Cagnacci, F. (2021). Experimental evidence of memory-based foraging decisions in a large wild mammal. *Proceedings of the National Academy of Sciences*, *118*(15), e2014856118, 1–9.
Read, D., & Hills, T. (2021). A negotiation in Middlemarch. *Negotiation Journal*, *37*(2), 203–220.
Sarbin, T. R. (1997). The poetics of identity. *Theory & Psychology*, *7*(1), 67–82.
Shiller, R. J. (2020). *Narrative economics*. Princeton University Press.
Suddendorf, T., & Corballis, M. C. (2007). The evolution of foresight: What is mental time travel, and is it unique to humans? *Behavioral and Brain Sciences*, *30*(3), 299–313.
Tolman, E. C. (1948) Cognitive maps in rats and men. *Psychological Review*, *55*, 189–208.

Brave new world: Imaginative fictions offer simulated safety and actual benefits

Jenny E. Nissel and Jacqueline D. Woolley

Department of Psychology, The University of Texas at Austin, Austin, TX 78712, USA
jenny.nissel@utexas.edu, woolley@austin.utexas.edu
https://labs.la.utexas.edu/woolley/

doi:10.1017/S0140525X21002284, e289

Abstract

Human engagement with imaginary worlds pervades history (e.g., Paleolithic cave paintings) and development (e.g., 18-month-olds pretend). In providing a safe environment, separate from the real world, fiction offers the opportunity for simulated exploration regardless of external circumstances. Thus, engagement with imaginary worlds in fiction may afford individuals opportunities to reap benefits and transfer these benefits back to the real world.

We aim to build on Dabourg and Baumard's proposal that imaginary worlds exploit evolutionary preferences for exploration, and appreciate the authors' suggestion that throughout recorded history, our interest in fictions with imaginary worlds has grown. Yet we do not find this surprising, given that advances in technological innovation throughout recorded history have encouraged both production and dissemination of these fictions. What we do find surprising is that evidence of engagement with imaginary worlds stretches back to a time when all of our resources should have gone toward survival. Nevertheless, 41,000-year-old representational images depicting sequential actions on the walls of caves in modern-day Indonesia suggest that we used valuable resources like time, fats, furs, and sticks to record narratives. Given production costs, one might assume these stories to have been realistic, practical. However, these hunting fictions were fantasies, characterized by therianthropes, humanlike figures with animal features. Other prehistoric fantastical creatures unearthed across the globe (e.g., a lion-headed woman in modern-day Germany, the birdman of Lascaux) reinforce the existence of a species-wide drive to engage with fantastical narrative (Aubert et al., 2019). Thus, in times when, presumably, securing safety

was a constant struggle, humans spun stories to explore imaginary worlds, and this tendency has persisted throughout history.

Though we also acknowledge the appeal of Dabourg and Baumard's argument that external environmental safety increases motivation to explore imaginary worlds, the prevalence of fantastical imagery in Paleolithic cave paintings suggests that these desires are robust even in dangerous or uncertain times. Returning to the present, consider these statistics from the United States in 2020: 11 of the top 20 grossing films were arguably fictions with imaginary worlds (IMDbPro, 2021). Sales of graphic novels (a genre dominated by otherworldly fictions, e.g., *Strange Planet* and *Stranger Planet*) jumped 29.1%. *The Ballad of Songbirds and Snakes*, set in the richly lithographed, chronologized republic of Panem, topped the young adult bestseller list (Hartman, 2021). Now consider the environmental conditions of the United States in 2020: a new pandemic without a cure took 380,000 American lives, and an old way of living had become unsafe. By the authors' argument, one might have expected us to avoid exploratory forays into fictional worlds to concentrate our energies on survival. Instead, we turned to imaginary worlds. We propose that imaginative fictions provide an outlet for exploration that is especially useful precisely when an individual's sense of external safety is threatened.

Fiction affords us the opportunity to cast aside actual circumstances and behave "as if" imaginary circumstances were real. The capacity to simulate is present early in development: children pretend by 18 months (Gopnik, 2009). With age, this may develop into a tendency to engage with fiction – to read, and to watch movies and television (Bloom, 2010). Though children's effortless navigation of this boundary between real and pretend was once taken as evidence that they couldn't tell the two apart (Piaget, 1929), it is now well-established that children as young as 3 understand fiction as distinct from reality (Woolley, 1997; Woolley & Ghossainy, 2013). Thus, when we enter a fictional world, though we *explicitly* believe that the circumstances are fictional, we can *implicitly* believe – or *alieve* – that they are real (Gendler, 2008). Our *alief* enables us to suspend our disbelief and engage with a fictional world – regardless of the conditions of our external reality.

Moreover, when the conditions of external reality are unsafe or aversive, fiction provides opportunities to escape into other realms. For example, the National Institutes of Health (NIH) estimated that 89% of children who experience sexual abuse create imaginary companions (Sanders, 1992). Children who experience trauma and escape into the relative safety of imaginary worlds seem to fare better than those who experience trauma and don't. Marjorie Taylor tells of Miriam, who created an imaginary companion with otherworldly abilities during her parents' divorce and mother's confinement to a mental hospital, and compares her to her older siblings who did not. While her siblings regressed, experiencing difficulties with school and sleep, Miriam experienced no such disturbances (Taylor, 1999). In subsequent work, Taylor showed that at-risk middle school children who created imaginary companions showed increased adjustment by high school (Taylor, Hulette, & Dishion, 2010). These findings suggest that the ability to explore challenging issues in a marked safe space separate from reality – especially when reality is unsafe – affords emotional and cognitive benefits.

Even when reality is not unsafe but merely presents an obstacle, fantastical pretense may still confer benefits. Children who pretend to be Batman or Elsa from Frozen persist longer on a potentially frustrating executive function key and lock matching task (White & Carlson, 2016); the authors suggest that the psychological distance between self and fantastical character enables children to explore options and perform more successfully in their own lives. Furthermore, Hopkins and Lillard (2021) suggest that problem solving can be enhanced through fantasy. The authors propose that it is not engagement with surface fantasy – a world superficially dissimilar to ours – that leads to these effects, but engagement with *deep* fantasy – a world dissimilar to ours where impossible things can happen, not unlike the settings of fictions with imaginary worlds. This is consistent with research suggesting that thinking about fantastical worlds results in myriad psychological outcomes, improving analogical reasoning, reasoning about minds, and information retention (e.g., Dias & Harris, 1990; Lillard & Sobel, 1999; Weisberg & Hopkins, 2020).

Thus, fictions with imaginary worlds, in providing conditions that foster psychological distance and deep processing, may have the potential to uniquely confer adaptive outcomes in the real world. Through offering a world distinct from the real one, imaginative fiction might be more than multisensory cheesecake, not only grabbing attention but also serving as an outlet for simulated exploration regardless of the nature of the external environment.

> Escapist fiction … opens a door … gives you a place to go where you are in control … gives you knowledge about the world and your predicament … weapons … armour: real things you can take back into your prison. Skills and knowledge and tools you can use to escape for real. (Gaiman, 2013)

Funding. This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Conflict of interest. None.

References

Aubert, M., Lebe, R.., Oktaviana, A., Tang, M., Buhran, B., Jusdi, A., … Brumm, A. (2019). Earliest hunting scene in prehistoric art. *Nature*, *576*, 442– 445.

Bloom, P. (2010). *How pleasure works*. W.W. Norton & Company.

Dias, M. G., & Harris, P. L. (1990). The influence of the imagination on reasoning by young children. *British Journal of Developmental Psychology*, *8*(4), 305–318.

IMDbPro. (2021). *Domestic box office for* 2020. Box Office Mojo. https://www.boxofficemojo.com/year/2020/.

Gaiman, N. (2013). Why our future depends on libraries, reading, and daydreaming. *The Guardian*. https://www.theguardian.com/books/2013/oct/15/neil-gaiman-future-libraries-reading-daydreaming.

Gendler, T. S. (2008). Alief in action (and reaction). *Mind & Language*, *23*(5), 552–585.

Gopnik, A. (2009). *The philosophical baby: What children's minds tell us about truth, love, and the meaning of life*. Farrar, Straus and Giroux.

Hartman, L. (2021). Breaking down 2020 bestsellers by publisher. *Publishers Weekly*. https://www.publishersweekly.com/pw/by-topic/industrynews/bookselling/article/85330breaking-down-the-bestselling-books-of-2020.html.

Hopkins, E. J., & Lillard, A. S. (2021). The Magic School Bus dilemma: How fantasy affects children's learning from stories. *Journal of Experimental Child Psychology*, *210*, 105212.

Lillard, A. S., & Sobel, D. (1999). Lion kings or puppies: The influence of fantasy on children's understanding of pretense. *Developmental Science*, *2*(1), 75–80.

Piaget, J. (1929). *The child's conception of the world*. Routledge & Kegan Paul.

Sanders, B. (1992). The imaginary companion experience in multiple personality disorder. *Dissociation*, *5*, 159–162.

Taylor, M. (1999). *Imaginary companions and the children who create them*. University Press.

Taylor, M., Hulette, A. C., & Dishion, T. J. (2010). Longitudinal outcomes of young high-risk adolescents with imaginary companions. *Developmental Psychology*, *46*(6), 1632.

Weisberg, D. S., & Hopkins, E. J. (2020). Preschoolers' extension and export of information from realistic and fantastical stories. *Infant and Child Development*, *29*(4), e2182.

White, R. E., & Carlson, S. M. (2016). What would Batman do? Self-distancing improves executive function in young children. *Developmental Science*, *19*(3), 419–426.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Woolley, J. D. (1997). Thinking about fantasy: Are children fundamentally different thinkers and believers from adults? *Child Development*, *68*(6), 991–1011.
Woolley, J. D., & E. Ghossainy, M. (2013). Revisiting the fantasy–reality distinction: Children as naïve skeptics. *Child Development*, *84*(5), 1496–1510.

All non-real worlds provide exploration: Evidence from developmental psychology

Katherine E. Norman[a] and Thalia R. Goldstein[b]

[a]Department of Educational Psychology, University of Wisconsin, Madison, WI 53703, USA and [b]Department of Psychology, George Mason University, Fairfax, VA 22030, USA
knorman4@wisc.edu
tgoldste@gmu.edu
https://edpsych.education.wisc.edu/staff/norman-katherine/
https://psychology.gmu.edu/people/tgoldste

doi:10.1017/S0140525X21002314, e290

Abstract

While Dubourg and Baumard argue that predisposition toward exploration draws us to fictional environments, they fail to answer their titular question: "Why *Imaginary* Worlds?" Research in pretend play, psychological distancing, and theatre shows that being "imaginary" (i.e., any type of unreal, rather than only fantastically unreal) makes exploration of any fictional world profoundly different than that of real-life unfamiliar environments.

Dubourg and Baumard (D&B) connect the human desire to explore unfamiliar environments to engagement with imaginary worlds, defined by them as worlds that are far from reality, fantastical, and primarily drawn from the Western canon of literature, film, and games. The authors ask: "what exactly is the cultural advantage of fictions with imaginary worlds over nonfictions describing the real world (e.g., history books, travel books)?" (target article, sect. 7.1, para. 1). While the authors argue our predisposition toward exploration and novelty draws us to new, alternative, or fictional environments, they fail to answer the primary question posed in their title: "Why *Imaginary* Worlds?" We can no more visit Renaissance Europe than Middle Earth, but the authors offer no rationale for including the imaginary but not the historical in their analysis. In contrast, research, practice, and theory in childhood pretend play, psychological distancing, and theatrical acting show that the quality of being "imaginary" (defined as anything unreal, rather than necessarily fantastical) makes the exploration of imaginary worlds profoundly different than that of unfamiliar environments in real-life, regardless of the distance the world has from reality. Moreover, research on cultural variance in children's pretend play serves to highlight the unexamined Eurocentrism of the target article.

Moving from reality into pretense of any form is theorized to provide emotional and exploratory safety to experience narratives and environments. The fictionality of imaginary worlds quarantines their contents from the real world (Leslie, 1987; Nichols & Stich, 2000), thus providing the psychological distance to enable safe – and potentially highly exploratory – engagement within them (Liberman & Trope, 2014). Quarantining is proposed regardless of the distance from reality these fictional spaces hold; whether they are naturalistic reflections of the real world, or highly fantastical and highly distanced in space or time. Similarly, the "fictional frame" theory within theatre has, for decades, described the ways a theatrical scenario allows action within a "no-penalty zone," wherein consequences are lowered – if not removed – compared to the real world (Boland, 2013; Heathcote, 1985).

This "frame" exists in childhood pretend play as well as the theatre. Just as imaginary scenarios of the stage are bounded by the proscenium, so too do children quarantine the content of their imaginations within their play (Weisberg, 2015; Wyman, Rakoczy, & Tomasello, 2009). Quarantining the pretense world away from the real is a defining quality of pretend play: If the imaginary content starts to bleed into the real world too much, the behavior stops being play (Buchsbaum, Bridgers, Skolnick Weisberg, & Gopnik, 2012; Rafetseder, Cristi-Vargas, & Perner, 2010; Weisberg & Gopnik, 2013). The contents of fictions exist, then, within a distinct cognitive space (Nichols & Stich, 2000, 2003). Findings in psychological distancing suggests that this cognitive separation is what enables the exploratory behaviors named by D&B in the target article (Liberman, Trope, & Stephan, 2007; Semin & Smith, 1999), rather than any far or fantastical fictionality. Regardless of the distance from reality, learning and emotions generated through quarantined explorations of the content within fictional frames have been shown to carry forward into the "real" world (e.g., Goldstein & Lerner, 2018; Pierucci, O'Brien, McInnis, Gilpin, & Barber, 2014; Sutherland & Friedman, 2012, 2013; Thibodeau, Gilpin, Brown, & Meyer, 2016; White & Carlson, 2015). In fact, young children may not even prefer highly or moderately fantastical pretense at all. Recent findings show American preschool children have a preference for real and realistic activities over fantastical ones (Taggart, Heise, & Lillard, 2018, 2020), and the insistence on high fantastical play may be a uniquely modern and American one (Lillard & Taggart, 2019).

In addition to the ways neglecting evidence around pretend play impoverishes the authors' argument on why humans engage with imaginary worlds, it also results in an unchallenged Eurocentric perspective on the imaginary within the target article. The evidence presented on engagement with fantastical worlds does not take into consideration developmental and anthropological evidence on varying realism and pretense preferences in pretend play across cultures. For example, some Mennonite and Amish communities in the United States actively discourage fantasy-orientated pretend play for their children (Carlson, Taylor, & Levin, 1998; Hostetler & Huntington, 1971). More mainstream Christian communities tend to support children's involvement in fantasy activities such as participation in rituals involving fantasy characters such as Santa Claus (Clark, 1998), but these same communities often ban or discourage fantastical books and games while allowing for other types of fiction (Waldron, 2005). Mayan children in the Yucatán engage in play that is both less frequent, less fantastical, and ceases earlier than European-American children (Gaskins, 1999). Pretend play observed in a Taiwanese community is highly valued as a way for mothers to explicitly instill models of proper conduct, and thus is highly realistic (Haight, Wang, Fung, Williams, & Mintz, 1999). Research with hunter-gatherer societies shows pretend play behaviors as highly dependent upon both the age and gender of participants, and that pretense is consistently realistic and tied to either rough-and-tumble simulations of fighting, or work-

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

themed play (Lew-Levy, Boyette, Crittenden, Hewlett, & Lamb, 2020). Thus, culture heavily influences engagement with the imaginary; claiming high fantasy is an evolutionary derived behavior is not supported by play in other cultures. Until further research is undertaken that actively includes cultural variances in engagement with pretense, the authors can claim only to describe the foundations and evolution of fictions with imaginary worlds within specifically Western contexts.

The "fictional frame" that differentiates the unreal from the real appears across cultural, developmental, and aesthetic domains. This suggests that high fantasy is not a prerequisite for high exploration. The authors' focus on the fantastical in their examples of "imaginary" loses the distinction between the non-real and the fantastical, and provides no commentary on exploration that could exist within *any* framed fictional non-reality. By understanding that the proposed highly fantastical fictions are but one narrow, Western slice of how humans engage with the non-real, then the argument that "Imaginary Worlds" are what all humans desire for evolutionarily relevant exploration cannot be universally applied. In future work, researchers should begin by operationalizing how distance from reality is correlated with desires for safe exploration of self and emotions, and consider culturally specific developmental trajectories and outcomes.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Boland, G. (2013). Role and role distance: The Heathcote/Carroll collaboration that reframed the social context for drama-based learning and teaching. *NJ: Drama Australia Journal*, *37*, 53–64.

Buchsbaum, D., Bridgers, S., Skolnick Weisberg, D., & Gopnik, A. (2012). The power of possibility: Causal learning, counterfactual reasoning, and pretend play. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1599), 2202–2212.

Carlson, S., Taylor, M., & Levin, G.R. (1998). The influence of culture on pretend play: The case of Mennonite children. *Merrill-Palmer Quarterly* (1982–), *44*(4), 538–565.

Clark, C. D. (1998). *Flights of fancy, leaps of faith: Children's myths in contemporary America*. University of Chicago Press.

Gaskins, S. (1999). Children's daily lives in a Mayan village: A case study of culturally constructed roles and activities. In A. Göncü (Ed.), *Children's engagement in the world: Sociocultural perspectives* (pp. 25–60). Cambridge University Press.

Goldstein, T. R., & Lerner, M. D. (2018). Dramatic pretend play games uniquely improve emotional control in young children. *Developmental science*, *21*(4), 1–13.

Haight, W., Wang, X., Fung, H., Williams, K., & Mintz, J. (1999). Universal, developmental, and variable aspects of young children's play: A cross-cultural comparison of pretending at home. *Child Development*, *70*, 1477–1488.

Heathcote, D. (1985). Collected writings. In L. Johnson & C. O'Neill (eds.), *Dorothy Heathcote: Collected writings on education and drama*. (pp. 49–53) Hutchinson and Co.

Hostetler, J. A., & Huntington, G. E. (1971). Children in Amish society: Socialization and community education. Case Studies in Education and Culture Series.

Leslie, A. M. (1987). Pretense and representation: The origins of "theory of mind." *Psychological Review*, *94*, 412–422.

Lew-Levy, S., Boyette, A. H., Crittenden, A. N., Hewlett, B. S., & Lamb, M. E. (2020). Gender-typed and gender-segregated play among Tanzanian Hadza and Congolese BaYaka hunter-gatherer children and adolescents. *Child Development*, *91*(4), 1284–1301.

Liberman, N., & Trope, Y. (2014). Traversing psychological distance. *Trends in Cognitive Science*, *7*, 364–369.

Liberman, N., Trope, Y., & Stephan, E. (2007). Psychological distance. *Social Psychology: Handbook of Basic Principles*, *2*, 353–383.

Lillard, A. S., & Taggart, J. (2019). Pretend play and fantasy: What if Montessori was right?. *Child Development Perspectives*, *13*(2), 85–90.

Nichols, S., & Stich, S. (2000). A cognitive theory of pretense. *Cognition*, *74*(2), 115–147.

Nichols, S., & Stich, S. (2003). *Mindreading: An integrated account of pretense, self- awareness and understanding other minds*. Oxford University Press.

Pierucci, J. M., O'Brien, C. T., McInnis, M. A., Gilpin, A. T., & Barber, A. B. (2014). Fantasy orientation constructs and related executive function development in preschool: Developmental benefits to executive functions by being a fantasy-oriented child. *International Journal of Behavioral Development*, *38*(1), 62–69.

Rafetseder, E., Cristi-Vargas, R., & Perner, J. (2010). Counterfactual reasoning: Developing a sense of "nearest possible world". *Child Development*, *81*(1), 376–389.

Semin, G. R., & Smith, E. R. (1999). Revisiting the past and back to the future: Memory systems and the linguistic representation of social events. *Journal of Personality and Social Psychology*, *76*(6), 877.

Sutherland, S. L., & Friedman, O. (2012). Preschoolers acquire general knowledge by sharing in pretense. *Child Development*, *83*(3), 1064–1071.

Sutherland, S. L., & Friedman, O. (2013). Just pretending can be really learning: Children use pretend play as a source for acquiring generic knowledge. *Developmental Psychology*, *49*(9), 1660.

Taggart, J., Becker, I., Rauen, J., Al Kallas, H., & Lillard, A. S. (2020). What shall we do: Pretend or real? Preschoolers' choices and parents' perceptions. *Journal of Cognition and Development*, *21*(2), 261–281.

Taggart, J., Heise, M. J., & Lillard, A. S. (2018). The real thing: Preschoolers prefer actual activities to pretend ones. *Developmental Science*, *21*(3), e12582.

Thibodeau, R. B., Gilpin, A. T., Brown, M. M., & Meyer, B. A. (2016). The effects of fantastical pretend-play on the development of executive functions: An intervention study. *Journal of Experimental Child Psychology*, *145*, 120–138.

Waldron, D. (2005). Role-playing games and the Christian right: Community formation in response to a moral panic. *The Journal of Religion and Popular Culture*, *9*(1), 3–3.

Weisberg, D. S. (2015). Pretend play. *Wiley Interdisciplinary Reviews: Cognitive Science*, *6* (3), 249–261.

Weisberg, D. S., & Gopnik, A. (2013). Pretense, counterfactuals, and Bayesian causal models: Why what is not real really matters. *Cognitive Science*, *37*(7), 1368–1381.

White, R. E., & Carlson, S. M. (2015). What would Batman do? Self-distancing improves executive function in young children. *Developmental Science*, *19*(3), 419–426.

Wyman, E., Rakoczy, H., & Tomasello, M. (2009). Young children understand multiple pretend identities in their object play. *British Journal of Developmental Psychology*, *27*(2), 385–404.

Young children are not driven to explore imaginary worlds

Angela Nyhout[a] and Ruth Lee[b]

[a]School of Psychology, University of Kent, Canterbury CT2 7FS, UK and [b]School of Psychology, Queen's University Belfast, Belfast BT7 INN, UK
a.nyhout@kent.ac.uk
ruth.lee@qub.ac.uk

doi:10.1017/S0140525X2100234X, e291

Abstract

We address Dubourg and Baumard's claim that imaginary worlds are most appealing early in the lifespan when the exploratory drive is highest. Preschool-age children prefer fictions set in the real world, and fantastical information can be difficult for children to represent in real time. We speculate that a drive to explore imaginary worlds may emerge after children acquire substantial real-world skills and knowledge. An account of age effects on fictional preferences should encompass developmental change.

A central claim by Dubourg and Baumard (D&B) is that imaginary worlds are most popular in childhood because learning via exploration is a primary function of this life stage. However, research suggests that preschool children do not prefer imaginary worlds that deviate from the real world over those situated in the real world, and that children and adults find some aspects of imaginary worlds difficult to represent. We argue that this is a problem for D&B's claim as currently presented. If imaginary worlds are popular primarily because they satisfy an adaptive

preference for exploration, why does a drive to explore such worlds fail to manifest early in development?

Real-world exploratory behaviour is at its highest in early to middle childhood (Blanco & Sloutsky, 2021), and D&B seem to argue that imaginary world preferences should track with this real-world drive. To support their argument, D&B cite market evidence on the popularity of imaginary worlds in childhood and data from a study finding a negative correlation between age and imaginary world preferences (Dubourg, Thouzeau, de Dampierre, & Baumard, 2021). However, market data provide limited insights given that parents strongly influence children's media consumption, and the cited correlational study included only adult participants (aged 18.5–32.7 years). If imaginary worlds serve as fertile ground for exploration in childhood, it is curious that developmental research indicates a lack of drive to engage with them in young children. Children's play, imagination and future thinking all tend towards the realistic rather than the fantastical (Harris, 2021), and preschool children prefer realistic to fantastical fiction, both in their consumption (Barnes, Bernstein, & Bloom, 2015) and production (Weisberg, Sobel, Goodstein, & Bloom, 2013) of stories. Harris (2021) suggests that preschoolers' reality bias amounts to a systematic assimilation of fantastical fictions to the real world, in contrast to the bottom-up world-building that D&B describe.

One possible reason for this might be that young children find certain aspects of imaginary worlds difficult to represent and process. Fictions present multiple types of novel information that consumers must integrate into a mental model that is continually updated as a narrative progresses (Zwaan & Radvansky, 1998), such as information about time, characters and their goals, fictional spaces and settings, and specific fictional rules and laws that apply within the world (e.g., causal principles, customs). During reading experiences, pre-adolescent children fail to monitor these factors in real time in the same way as adults (Bohn-Gettler, Rapp, Van den Broek, Kendeou, & White, 2011). A particular problem for D&B's proposal arises when we consider spatial information. A central feature of their account is that exploring an imaginary world implies an ability to construct a mental map by representing and updating such information (target article, sect. 2, para. 2), an ability they suggest is born of evolutionarily ancient wayfinding behaviour (target article, sect. 4.2, para. 2). Both adults and children have difficulty constructing detailed spatial representations of new fictional worlds in narratives in the absence of visual input (Nyhout & O'Neill, 2017; Zwaan & Radvansky, 1998), and a comparison of 7-year-old children and adults suggests that children find this relatively more difficult than adults (Nyhout, 2015).

A further challenge is posed by the fact that much fictional information contradicts the consumer's knowledge of the real world. Adults are able to quickly integrate this kind of information into a mental model (Ferguson & Sanford, 2008, present vegetarian cats; Nieuwland & Van Berkum, 2006, introduce lovelorn peanuts). Whether this is the case for children is not yet clear, although preliminary evidence suggests that a difficulty in processing knowledge of a fantastical world arises for children during real-time sentence interpretation. After listening to brief stories in which fantastical protagonists were said routinely to perform actions that contradicted participants' semantic and real-world knowledge (e.g., Wendy the witch has keys for her lunch; she doesn't have sandwiches for her lunch), and then hearing that (e.g.) "Wendy is eating…," 7-year-olds looked predictively to a picture of (e.g.) a sandwich, and adults to a picture of a key, at a rate above chance (Lee, Chambers, Huettig, & Ganea, 2017). That is, children tacitly predicted that an overtly fantastical story character would act in accordance with children's real-world knowledge, rather than with features of an imaginary world as explicitly described to them (Lee et al., 2017; Lee et al., in prep.).

A proposal that accounts for the complexity of narrative stimulus (i.e., the nature and degree of departure from the real world) in relation to developing cognitive abilities could help to explain children's preferences for reality-based fictions while still allowing for an exploratory drive to explain fictional preferences. If the function of the exploratory drive in childhood is to allow children to acquire new skills and information, there might be counterproductive outcomes for children of spending time in imaginary worlds when they still have much to learn about the real world. For this reason, we might expect imaginary worlds that have a substantial degree of overlap with the real world to appeal to young children. Indeed, young children are sensitive to the distinction between "near" and "far" (highly fantastical) fictional worlds, and use them in deciding what kind of information to "quarantine" rather than transfer to the real world (Richert & Smith, 2011; Walker, Gopnik, & Ganea, 2015). Only later in development, when children have acquired sufficient real-world skills and knowledge, might we expect a broader imaginary world preference to appear – perhaps as early as late childhood or adolescence.

Imaginary world preferences do not seem to be a straightforward function of a drive to explore the real world, at least for the brief fictional narratives that have been studied to date. Future work could investigate children's preferences when presented with other stimuli, such as movie-like scenarios that include complex visual scenes. Harris (2021) suggests that future research could also address the extent to which children's imagination is constrained by reality across the course of development. Here, an elaborated version of D&B's proposal – one that sets out to address developmental change, and addresses the matter of evolutionary advantage in that context – might be an interesting and useful starting point.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Barnes, J. L., Bernstein, E., & Bloom, P. (2015). Fact or fiction? Children's preferences for real versus make-believe stories. *Imagination, Cognition and Personality: Consciousness in Theory, Research, and Clinical Practice*, *34*, 243–258. https://doi.org/10.1111/cdep.12128.

Blanco, N. J., & Sloutsky, V. M. (2021). Systematic exploration and uncertainty dominate young children's choices. *Developmental Science*, *24*(2), e13026.

Bohn-Gettler, C. M., Rapp, D. N., Van den Broek, P., Kendeou, P., & White, M. J. (2011). Adults' and children's monitoring of story events in the service of comprehension. *Memory & Cognition*, *39*(6), 992–1011.

Dubourg, E., Thouzeau, V., de Dampierre, C., & Baumard, N. (2021). Exploratory preferences explain the cultural success of imaginary worlds in modern societies. *PsyArXiv*, 1–19. https://doi.org/10.31234/osf.io/d9uqs.

Ferguson, H. J., & Sanford, A. J. (2008). Anomalies in real and counterfactual worlds: An eye-movement investigation. *Journal of Memory and Language*, *58*(3), 609–626.

Harris, P. L. (2021). Early constraints on the imagination: The realism of young children. *Child Development*, *92*(2), 466–483.

Lee, R., Chambers, C. G., Huettig, F., & Ganea, P. A. [Unpublished manuscript]. Adults, but not children use fictional information to override stored semantic knowledge during anticipatory linguistic processing.

Lee, R., Chambers, C. G., Huettig, F., & Ganea, P. A. (2017). Children's semantic and world knowledge overrides fictional information during anticipatory language processing. In G. Gunzelmann, A. Howes, T. Tenbrink & E. Davelaar (Eds.), *Proceedings of the 39th annual conference of the Cognitive Science Society* (pp. 730–735). Cognitive Science Society.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Nieuwland, M. S., & Van Berkum, J. J. (2006). When peanuts fall in love: N400 evidence for the power of discourse. *Journal of Cognitive Neuroscience*, *18*(7), 1098–1111.
Nyhout, A. (2015). *Imagining story spaces: Young readers' ability to construct spatial representations of narrative*. [Doctoral Dissertation, University of Waterloo]. UW Space. https://uwspace.uwaterloo.ca/handle/10012/9442.
Nyhout, A., & O'Neill, D. K. (2017). Children's enactment of characters' movements: A novel measure of spatial situation model representations and indicator of comprehension. *Mind, Brain, and Education*, *11*(3), 112–120.
Richert, R. A., & Smith, E. I. (2011). Preschoolers' quarantining of fantasy stories. *Child Development*, *82*(4), 1106–1119.
Walker, C. M., Gopnik, A., & Ganea, P. A. (2015). Learning to learn from stories: Children's developing sensitivity to the causal structure of fictional worlds. *Child Development*, *86*(1), 310–318.
Weisberg, D. S., Sobel, D. M., Goodstein, J., & Bloom, P. (2013). Young children are reality-prone when thinking about stories. *Journal of Cognition and Culture*, *13*, 383–407.
Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin*, *123*(2), 162.

Exploration and arrangement in physical and social worlds

Keith Oatley

Department of Applied Psychology and Human Development, University of Toronto, Toronto, Ontario M5S 1V6, Canada
keith.oatley@utoronto.ca; https://sites.google.com/site/keithoatleyhomesite

doi:10.1017/S0140525X21002119, e292

Abstract

Fiction involves exploring imaginative arrangements of places and characters: elements that can be recognized by readers. In childhood, exploration occurs from a safe home base of a caregiver; fiction enables a comparable basis. Physical elements in fiction are settings. More important are social explorations: transactions with characters that can include transformation. This is illustrated by *Alice's Adventures in Wonderland*.

A valuable discussion of the success of stories based on the exploration of imagined places is offered in the target article by Dubourg and Baumard (D&B). In this commentary, I suggest that their proposal may be extended in three ways.

First is the importance of arrangement. This can be seen if you explore the Loire Valley, in France, arrive at Angers and visit the Château. There displayed is the Apocalypse Tapestry, designed by Jean Bondol, who was active between 1368 and 1381. Among its images is one of a town, said to be what Paradise is like, accompanied by two figures who gaze at it. One is God-the-Father, looking very much like a human being sitting on a cloud. The other is John the Baptist, standing at the side. Paradise is evidently a small fortified town built before the beginning of the fifteenth century. Although the image and its background story are imagined, the elements – medieval town, one person sitting and one standing, cloud – are not.

Fiction has a Latin etymology, meaning "something made." But this doesn't mean "made up." In creating a story or image, authors and artists use pieces of what they know, which others can recognize, and arranging these pieces as elements configured in a new way. The elements themselves are not imagined.

A second aspect draws on D&B's discussion of how children explore and show greater preference than adults for stories of imaginary worlds. Relevant here is John Bowlby's theory of attachment in which a child and caregiver keep close together so the child is protected from harm. When the child can move about, the caregiver functions as a secure base (Bowlby, 1988) from which exploration can occur. Gopnik (2020) has found that children's exploration is related to play and involves a broader search of hypotheses than happens in adults. Stories can be thought of as deriving from play, and do not endanger people as physical exploration sometimes does. As in attachment with a caregiver, readers and viewers are safe.

A third aspect is that, in fiction, physical exploration is usually accompanied by exploration of the social world: personal and interpersonal. This receives little attention in the target article. As described in the previous paragraph, interpersonal issues begin early in life. A famous children's novel (mentioned in the target article) which explores these features is *Alice's Adventures in Wonderland* (Carroll, 1865/1965).

At the start of this story Alice, perhaps about 10 years old, is with her older sister (caregiver). We may infer from the words "tired" in the first paragraph, and "sleepy" in the second, that the White Rabbit, whom she sees running past, occurs in a dream. The rabbit pops down a rabbit hole, and Alice follows. She enters the hole, then falls and keeps falling. She has learned from her lessons in the schoolroom about the earth, how it's 4,000 miles to its center; she wonders whether she will reach New Zealand or Australia. She passes cupboards and shelves. She then feels "dreamy." When Alice lands she isn't hurt but finds herself in a passage that leads to a hall with many doors. As with Jean Bondol's Paradise, there are physical elements: rabbit hole, cupboards, shelves, hall with doors. Lewis Carroll arranged these in a new way.

More important than physical elements, Alice undergoes changes. On a table in the hall is a golden key. She finds that it opens a door. Through the opening she sees the loveliest garden. The doorway is 15 inches tall. She cannot pass. She drinks from a bottle with a label that says, "Drink Me," and shrinks to a height of 10 inches. She'll be able to get through the door but can no longer reach the key on the table. She sees a very small cake, with a label that says, "Eat Me." She does so and becomes taller. She can now get the key but can no longer get through the door. She bursts into tears. The changes of size seem intended to harmonize with issues of a girl who will soon reach puberty. What is seen through the little door? Is it adulthood? Looks lovely! How big will she become? And what is the key?

Alice's tears form a large pool, in which she swims, accompanied by a mouse. When she reaches the shore, she meets other animals and also some people: the Dodo, the Cheshire Cat, the Mad Hatter, the Queen of Hearts, the Mock Turtle, the Gryphon, and so on. These beings have different personalities, some friendly, others dismissive, some just rather mad. The Queen of Hearts is threatening and keeps saying that people, who include Alice, should be beheaded.

Alice takes part in various activities, some of them like games. She is both playful and thoughtful, as a 10-year-old girl might be, trying to see what goes on in the world, encountering puzzles, not ever being able quite to understand but, when necessary, disagreeing with what other characters say. The story invites some giggling. For example, when Alice asks the Mock Turtle about his education:

> "Reeling and Writhing, of course, to begin with," the Mock Turtle replied; "and then the different branches of Arithmetic – Ambition, Distraction, Uglification and Derision." (Carroll, p. 129)

This story is an exploration with a primary purpose that is social. The suggestion is that one can understand something of others, all of whom have quirks. And one can understand hardly anything about the meaning of life, so what is one to do?

In the third edition of *Literature as Exploration* Rosenblatt (1965) proposed that readings of fiction are "interactions – or more precisely, transactions – between individual readers and the individual literary works" (pp. 26–27).

Places and objects are settings. Transactions occur between readers and characters, and often between readers and authors. Among other results are readers increasing their empathy for others (Oatley, 2016). In our explorations as readers, which are sometimes playful, we can move beyond our usual understandings; we can undergo personal transformation.

Funding. None.

Conflict of interest. None.

References

Bowlby, J. (1988). *A secure base: Clinical applications of attachment theory*. Routledge.

Carroll, L. (1865). Alice's adventures in Wonderland. In M. Gardner (Ed.), *The annotated Alice: Alice's adventures in Wonderland and through the looking glass, with an introduction and notes by Martin Gardner* (pp. 17–164). Penguin (current edition 1965).

Gopnik, A. (2020). Childhood as a solution to explore–exploit tensions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375* (1803), 20190502. https://doi.org/10.1098/rstb.2019.0502

Oatley, K. (2016). Fiction: Simulation of social worlds. *Trends in Cognitive Sciences*, *20*, 618–628. https://doi:org/10.1016/j.tics.2016.06.002

Rosenblatt, L. (1965). *Literature as exploration* (2rd ed.). Noble and Noble.

Am I present in imaginary worlds? Intentions, actions, and flow in mediated experiences and fiction

Federico Pianzola[a,b], Giuseppe Riva[c,d], Karin Kukkonen[e] and Fabrizia Mantovani[a]

[a]Department of Human Sciences for Education "R. Massa," University of Milan Bicocca, Milan 20126, Italy; [b]Department of Global Korean Studies, School of Media, Arts and Science, Sogang University, Seoul 04107, South Korea; [c]Humane Technology Lab., Università Cattolica del Sacro Cuore, Milan 20123, Italy; [d]Applied Technology for Neuro-Psychology Lab, Istituto Auxologico Italiano, Milan 20149, Italy and [e]Department of Literature, Area Studies and European Language, University of Oslo, Oslo 0371, Norway
federico.pianzola@unimib.it
giuseppe.riva@unicatt.it
karin.kukkonen@ilos.uio.no
fabrizia.mantovani@unimib.it

doi:10.1017/S0140525X2100220X, e293

Abstract

We support the idea of applying cultural evolution theory to the study of storytelling, and fiction in particular. However, we suggest that a more plausible link between real and imaginary worlds is the feeling of "presence" we can experience in both of them: we feel present when we are able to correctly and intuitively enact our embodied predictions.

Dubourg and Baumard's (D&B) main assumption is that a certain kind of fictional works ("world-dominant fictions") are mainly consumed because their imaginary worlds are attractive. Moreover, they assume that the exploration of imaginary worlds is similar to the exploration of a real physical space: "Humans would find imaginary worlds very attractive for the very same reasons, and under the same circumstances, as they are lured by unfamiliar environments in real life." The main issue with this assumption is that it ignores that our engagement with world-dominant fiction is a mediated experience, shaped by the way an author (or production team) decided to present a certain imaginary world to their audience. When engaging with stories, the sequentiality of the events presented and the narrative design (e.g., impersonal description or first-person perspective) are always guiding the exploration of the story world (Kukkonen, 2020). An example showing this – and disproving D&B's hypothesis about the cultural preference for imaginary worlds – is the unequal success of the two books *The Lord of the Rings* and *The Silmarillion* by J. R. R. Tolkien. Both books tell stories about the same imaginary world, but the narrative organization of *The Lord of the Rings* makes it more attractive than the richness of spatial information provided in *The Silmarillion* (e.g., 4.5 vs. 3.9 stars on the book reviews website Goodreads). Abstracting general patterns in cultural preferences for fiction will require more empirical investigations of how fictional stories spread and become popular.

Rather than the mere opportunity for exploration, a more plausible link between real and imaginary worlds lies potentially in the feeling of "presence" we can experience in both of them. Presence is the self-perception of skillful agency: we feel present when we are able to correctly and intuitively enact our embodied predictions. And humans are attracted to imaginary worlds and characters because stories allow them to accumulate evidence to find the best explanation for their sensations (Friston, Rosch, Parr, Price, & Bowman, 2017; Pianzola, Riva, Kukkonen, & Mantovani, 2021). Narrative is a training ground for the development of our ability to predict the causes of signals coming from the environment and from our inner states (Friston, 2010; Seth & Friston, 2016) because it provides "alternate hypotheses that generalize and therefore preclude overfitting (sensory) data" (Bouizegarene, Ramstead, Constant, Friston, & Kirmayer, 2020). By engaging with stories, humans become more skillful agents; they become better at adapting to and interacting with the environment and others.

We are able to generalize from imaginary worlds to the real world because both explorations are guided by the sense of presence induced by the correct enaction of our embodied predictions and intentions. However, every time we pick up a book or turn on a screen, we know that we cannot explore imaginary worlds in the same way as we do in the real world, therefore we cannot be attracted to world-dominant fictions "for the very same reasons, and under the same circumstances." We know that engaging with a fiction world is a mediated experience (Fig. 1), shaped by the choices that someone made in creating a story (first-order mediation) and by the fictional characters that inhabit it, because we often perceive the world from their perspective (second-order mediation), enacting their consciousness (Caracciolo, 2014).

The double mediation and the scaffolding of readers' engagement with fictional worlds through narrative design point to another problematic omission in D&B's discussion.

They do not clarify whether humans have a specific preference for the exploration of space or they tend to explore new situations

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

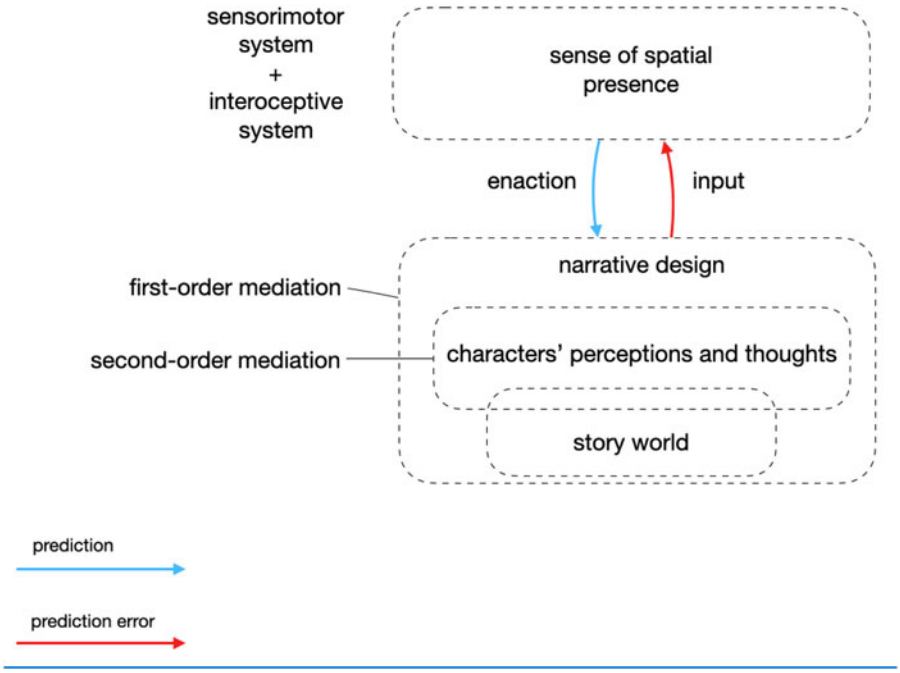

Figure 1 (Pianzola et al.). Double mediation process of the cognitive access to story worlds (cf. Pianzola et al., 2021).

in general. If it is a general bias (as it seems from the evidence they quote from developmental psychology), the popularity of imaginary worlds versus other genres cannot be explained in terms of desire for exploration of story space in the authors' terms. After all, even stories with poorly-defined imaginary worlds invite an exploration of characters' minds, experiences, and their relations to other characters, which can all be understood as "situations." Indeed, the evidence for "openness to experience" in readers cited by the authors suggests that also the appreciation of genres where non-spatial situations are dominant correlates with this personality trait. The model of mediation and presence, on the other hand, applies to both spatial and interpersonal situations.

D&B highlight that cognition is fundamental to how culture develops. We agree, but we suggest that there is a feedback loop: cultural and media forms shape cognition throughout history. The more a medium or cultural artefact (e.g., narrative) is able to support the correct enactment of an individual's predictions and to clarify the intentions of others, the stronger is the sense of presence experienced with the medium or cultural artefact. In conclusion, an optimal balance between predictions and prediction errors (flow) facilitates the emergence of a sense of presence in both real and fictional worlds. This common embodied cognitive process is what allows us to generalize from imaginary worlds to the real world, even though we use different skills and cognitive and cultural schemata when exploring fiction.

Funding. FP was financially supported by the European Union's Horizon 2020 research and innovation program under the grant agreement No 792849 (project READIT).

Conflict of interest. None.

References

Bouizegarene, N., Ramstead, M. J. D., Constant, A., Friston, K. J., & Kirmayer, L. (2020). *Narrative as active inference* [Preprint]. PsyArXiv. https://doi.org/10.31234/osf.io/47ub6.

Caracciolo, M. (2014). *The experientiality of narrative: An enactivist approach*. de Gruyter.

Friston, K. J. (2010). The free-energy principle: A unified brain theory? *Nature Reviews Neuroscience*, *11*(2), 127–138. https://doi.org/10.1038/nrn2787.

Friston, K. J., Rosch, R., Parr, T., Price, C., & Bowman, H. (2017). Deep temporal models and active inference. *Neuroscience & Biobehavioral Reviews*, *77*, 388–402. https://doi.org/10.1016/j.neubiorev.2017.04.009.

Kukkonen, K. (2020). *Probability designs: Literature and predictive processing*. Oxford University Press.

Pianzola, F., Riva, G., Kukkonen, K., & Mantovani, F. (2021). Presence, flow, and narrative absorption: An interdisciplinary theoretical exploration with a new spatiotemporal integrated model based on predictive processing. *Open Research Europe*, *1*(28), 1–37. https://doi.org/10.12688/openreseurope.13193.2.

Seth, A. K., & Friston, K. J. (2016). Active interoceptive inference and the emotional brain. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *371*(1708), 1–10. https://doi.org/10.1098/rstb.2016.0007.

Why do people *create* imaginary worlds? The case of Fanfiction

Bárbara Rodríguez-Fuentes[a] and José Luis Ulloa[a,b]

[a]Facultad de Psicología, Universidad de Talca, Talca CP 3460000, Chile and [b]Programa de Investigación Asociativa (PIA) en Ciencias Cognitivas, Centro de Investigación en Ciencias Cognitivas (CICC), Facultad de Psicología, Universidad de Talca, Talca, Chile
brodriguez17@alumnos.utalca.cl
joulloa@utalca.cl
http://cicc.utalca.cl/

doi:10.1017/S0140525X21002235, e294

Abstract

Dubourg and Baumard ask why people consume fiction with imaginary worlds. We extend this inquiry to ask why people engage in creating imaginary worlds. In Fanfiction, the writing of fiction by fans involves both an immersive creative experience and a very interactive community that may explain the high (social) engagement of people with Fanfiction.

Dubourg and Baumard (D&B) wonder why people invest resources to consume imaginary worlds-fiction. Here, we wonder why people invest time and effort *creating* imaginary worlds. We use Fanfiction as a case study. Fanfiction is a form of creative literature where the writer explores plot gaps and alternatives in the original story to elaborate an imaginary world colored with her own values and thoughts (Black, 2005). The creative work in Fanfiction involves a continuous remodeling of the characters (Black, 2007) and plot changes involving more than one topic at the same time (Bahoric & Swaggerty, 2015). This dynamic creative process results from the interaction of writers with other fans through a massive spread of Fanfiction through the Internet (Lankshear & Knobel, 2006). Indeed, as the writer of Fanfiction transforms the original story into her own fanfic, the new story can be refined by the readers of that fanfic too. The work of Fanfiction is further remodeled by exchanges between readers of the fanfic and fans of the original story resulting in new additions and changes (Mackey & Mcclay, 2008). Finally, in order to gain better visibility, the fanfic created is sometimes overseen by beta-readers, who provide feedback before it is published on the web. Overall, Fanfiction is a highly dynamic creative process and requires a continuous engagement.

Why do people spend time and effort creating imaginary worlds as in the case of Fanfiction? One characteristic aspect of Fanfiction is exploration. Fanfiction writers are "curious" explorers insofar as they go beyond the original story ("the canon"; Black, 2005) and exhaust its options to create new imaginary worlds through writing. For example, in "crossovers," two pre-existing imaginary worlds are combined to generate new plots and interactions between characters (Samutina, 2016). However, this exploration arises out of an interest for an inner world that the story provides. Writing fanfics promotes a knowledge of oneself (personal exploration) and also of other people (Black, 2007). This kind of exploration involves the engagement with characters that evolve through the story and in their interactions (Thomas, 2011). This immersive experience may result in better insight of oneself and better abilities to think about others. The effects may be related to both reading and writing. Previous research suggests that reading and writing fiction can enhance our social skills and improve our abilities to face social and emotional difficulties and thus allows us to have better social interactions (Mar, Oatley, Hirsh, dela Paz, & Peterson, 2006). Reading fiction also makes us allocate our attention to our emotions and other people's emotions (Oatley, 2012). As we pay close attention to the unfolding of the story and the characters that appear, we are drawn by what other's emotions are experimenting in the story. This may allow us to train our empathy skills. In clinical psychology, "therapeutic letters" are used to help people to better visualize their life events, their own inner conflicts and offer interpretations of conflicts that occur in relationships with other people (Wojcik & Iverson, 1989). The use of writing is a means to express emotions and even to deal with painful situations. Oncology patients that have participated in programs based on narrative therapy – where writing is used to express painful emotions – show a notable improvement in the management of chronic non-cancer pain (Oller & Carrillo, 2020). The effects of reading and creating fiction have been suggested to rely on brain mechanisms that allow us to simulate hypothetical scenes, spaces, and mental states (Tamir, Bricker, Dodell, & Mitchell, 2016). While both reading and creating Fanfiction contribute to the development of social abilities, writing may permit an even higher development. Reading is a more passive activity than writing (Junker & Jacquemin, 2017) and writing implies a greater effort related to the craft of a new story and new characters (relative to the original work), and thus, imply a more active engagement (Samutina, 2016). Finally, Fanfiction may also enhance emotional regulation abilities in the reader. The story and characters allow us to draw parallels between fiction and real life, eliciting similar emotions in us (e.g., a relationship breakup; Oatley, 2012). Beyond that, since Fanfiction is such an immersive and engaging experience, it could induce emotional regulation through the interaction of readers and writers in a community. Fanfiction is a potent catalyst of social and emotional skills improvement, by means of its content (stories) and the form these stories are created and exchanged (interaction within the Fandom). It is this double character of Fanfiction that maybe boosts even more the development of social skills.

Developing social skills strongly impact our ability to relate to other people and to our environment. Our social skills facilitate the creation and maintenance of healthy relationships and provide us with social support (Barth, 1988). The lack of social skills due to lack of development in early human upbringing can lead to disruptive behavior, mental problems, and poor academic performance in adolescence (Rinn & Markle, 1979). Thus, an individual with appropriate social skills can have less chances of having psychopathologies and will have better chances of fulfilling his or her life (Hosokawa & Katsura, 2017). In response to D&B's question we wonder, why would people invest time and effort *creating* imaginary worlds? Fiction seems to allow better self-knowledge and knowledge of others. This in turn may impact our ability to form healthy relationships and in our quality of life. Fanfiction is characterized by members with a strong engagement toward their fellows and a community itself that also encourages the interaction and feedback between fans, readers, and writers (Bahoric & Swaggerty, 2015). Thus, exploration immersed in this massive interaction with others can compensate for any costs that creating new worlds might imply.

Acknowledgments. J.L.U. was supported by ANID/CONICYT FONDECYT Iniciación 11190673 and by the Programa de Investigación Asociativa (PIA) en Ciencias Cognitivas, Research Center on Cognitive Sciences (CICC), Faculty of Psychology, Universidad de Talca, Chile.

Conflict of interest. None.

References

Bahoric, K., & Swaggerty, E. (2015). Fanfiction: Exploring in-and out-of-school literacy practices. *Colorado Reading Journal*, *26*, 25–31.

Barth, R. (1988). Social skill and social support among young mothers. *Journal of Community Psychology*, *16*(2), 132–143.

Black, R. (2005). Access and affiliation: The literacy and composition practices of English-language learners in an online fanfiction community. *Journal of Adolescent & Adult Literacy*, *49*(2), 118–128.

Black, R. (2007). Fanfiction writing and the construction of space. *E-Learning and Digital Media*, *4*(4), 384–397.

Hosokawa, R., & Katsura, T. (2017). A longitudinal study of socioeconomic status, family processes, and child adjustment from preschool until early elementary school: The role of social competence. *Child and Adolescent Psychiatry and Mental Health*, *11*(1), 1–28.

Junker, C., & Jacquemin, S. (2017). How does literature affect empathy in students? *College Teaching*, *65*(2), 79–87.

Lankshear, C., & Knobel, M. (2006). Digital literacy and digital literacies: Policy, pedagogy and research considerations for education. *Nordic Journal of Digital Literacy*, *1*(1), 8–20.

Mackey, M., & Mcclay, J. (2008). Pirates and poachers: Fan fiction and the conventions of reading and writing. *English in Education*, *42*(2), 131–147.

Mar, R., Oatley, K., Hirsh, J., dela Paz, J., & Peterson, J. (2006). Bookworms versus nerds: Exposure to fiction versus non-fiction, divergent associations with social ability, and

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

the simulation of fictional social worlds. *Journal of Research in Personality*, *40*, 694–712.
Oatley, K. (2012). The cognitive science of fiction. *Wiley Interdisciplinary Reviews: Cognitive Science*, *3*(4), 425–430.
Oller, S., & Carrillo, K. (2020). La Narrativa Sistémica como modelo de intervención terapéutica en el manejo del dolor crónico no oncológico en mujeres. *Revista REDES*, (41).
Rinn, R., & Markle, A. (1979). Modification of social skill deficits in children. In: Bellack, A. S. & Hersen, M. (Eds.) *Research and practice in social skills training* (pp. 107–129). Springer.
Samutina, N. (2016). Fan fiction as world-building: Transformative reception in crossover writing. *Continuum*, *30*(4), 433–450.
Tamir, D., Bricker, A., Dodell, D., & Mitchell, J. (2016). Reading fiction and reading minds: The role of simulation in the default network. *Social Cognitive and Affective Neuroscience*, *11*(2), 215–224.
Thomas, B. (2011). What is fanfiction and why are people saying such nice things about it? *Storyworlds: A Journal of Narrative Studies*, *3*, 1–24.
Wojcik, J., & Iverson, E. (1989). Therapeutic letters: The power of the printed word. *Journal of Strategic and Systemic Therapies*, *8*(2–3), 77–81.

The call of the final frontier?

Catherine A. Salmon and Rebecca L. Burch

Psychology Department, University of Redlands, Redlands, CA 92373, USA
catherine_salmon@redlands.edu; rebecca.burch@oswego.edu

doi:10.1017/S0140525X21002247, e295

Abstract

The target article is focused on locating the popularity of imaginary worlds in our adaptations for exploration. This commentary touches on developmental influences, vicarious enjoyment, the challenging of societal mores, plot, and whether men and women are drawn to the same features in the same ways.

We agree with the authors that the time is ripe for evolutionary explanations of the appeal of various genres of popular culture, including works containing imaginary worlds and their connection to novelty-seeking or exploration. The authors state that the key determinant is that knowledge of the fictive world differs from knowledge of the real world. However, this criterion changes as our knowledge of the real world changes. An imagined far off world a few centuries ago, for example, is now far more familiar. Is this imagined world less imagined now? What is real versus imagined is very much dependent on the time and place of the writing. The authors acknowledge this when discussing *From the Earth to the Moon*. Who makes this judgment? Is the imagined world in the eye of the beholder? These issues and the overlap with other fictional genres make this definition rather nebulous.

We would argue that as the world has become more fully explored, stories described "just a town over" have become "in a far off exotic land," then "in a galaxy far, far away," to more easily suspend disbelief, to be less jarring in light of current knowledge. The expansion of imagined worlds is a logical next step after the expansion of known worlds. Authors are forced to create new mysterious planets as our own has become extensively studied. At present, we are left with space as the final frontier; there are no worlds left on this one to imagine. This suggests that imagined worlds are the natural progression of storytelling and have not exploded or expanded in recent years; they have just become more other worldly as humans have explored to the literal ends of the Earth.

The authors suggest that a significant appeal of imagined worlds comes from preferences for exploration which are also associated with not only risk-taking but also perhaps with sensation-seeking. This raises the question of developmental effects on risk preferences and how this relates to genre preferences. Sometimes when life is risky is when novelty-seeking may pay off most, as in high mortality, low-resource environments. Yet the authors suggest that more resource-rich environments are associated with more interest in imaginary world fiction. This raises several questions about the popularity of imagined worlds and their very creation. Surely less risk-averse cultures have more time and resources to devote to writing, publishing, and dispersing these stories, and cultures thrown into turmoil (and possible destruction) may lose their established works. As is too often the case, one is left wondering what data have been lost and what observations are myopic. What can researchers accurately observe regarding resources, risk, and imagined worlds? Moreover, is world building more interesting during the developmental period where risk is most attractive? Or is world building more interesting when trying to avoid REAL risk? This ties into the vicarious enjoyment of other people's risk when one is safe as well as the observational learning that occurs, especially during early developmental periods. Is world building more attractive to people who are risk attracted or risk averse? To people in developmental periods where they are generally more or less risk averse? And are fictional worlds more attractive in times of stress or uncertainty in the real world?

We would also argue that one of the motivations for creating an imagined world (and not a faithful representation of the real world) is also linked to risk; to challenge real-world societal mores without risking significant retaliation. Diverse populations have long found representation in imagined worlds, and science fiction and fantasy have long created allegories for civil rights and other advocacy.

As life-long female consumers of some of the films/fictions mentioned, we couldn't help but notice that the composition of the consumers in terms of sex was not discussed. In fact, many of these works have substantial female audiences and it would be useful to consider whether the appeal of these works to females is driven by the same factors as for males. Much of the attention paid to background knowledge as essential seems less relevant to female consumers who are often drawn as much or more to the characters, their relationships, and the challenges they face. Certainly, it is not the focus of most of the female produced fan fiction/art/music videos that have made websites such as AO3 (Archive of Our Own) so successful in terms of production and traffic. Those materials are very much focused on character and relationships, often of a romantic/sexual nature (Salmon & Burch, 2020; Salmon & Symons, 2004). What is the primary audience demographic of those imagined worlds without plot? We would suggest that the most popular/successful world-building fictions are not simply world building but character highlighting in terms of the personal and interpersonal challenges they face. Humans are drawn to plots that play on evolutionary themes: those of competition (or war) for resources or mates, romance, or yes, exploration. Likewise the character archetypes remain; the hero, the ingénue, etc. It appears that regardless of the setting, humans seek the same stories, variations on essential themes. How many LOTR fans would be drawn to the world created without the quest of the fellowship and the trials and tribulations as well as the triumphs of Aragorn, Frodo and company?

In short, is world building more popular now because the exploration of the real world has seemingly met its end? Is world building more popular now because the real world seems particularly risky or dangerous, or because real exploration has become more pedestrian, or simply because many other imagined worlds in ancient literature have not survived the ages? Is world building more popular with male readers, pointing to a greater desire for exploration? The great undiscovered country in many examples of imaginary worlds, for women, may be less the actual structure of the world and more the relationships between the people that inhabit it. Fictions that include both of these types of undiscovered country may be the most successful of all.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Salmon, C., & Burch, R. L. (2020). I'm with you till the end of the line: The romanticization of male bonds. In Carroll, J., Clasen, M., & Jonsson, E. (Eds.), *Evolutionary perspectives on imaginative culture* (pp. 291–305). Springer.

Salmon, C., & Symons, D. (2004). Slash fiction and human mating psychology. *Journal of Sex Research*, *41*(1), 94–100.

Imaginary worlds pervade forager oral tradition

Michelle Scalise Sugiyama

Anthropology Department, University of Oregon, Eugene, OR 97401, USA
mscalise@uoregon.edu
https://talkingstories.uoregon.edu/

doi:10.1017/S0140525X21002363, e296

Abstract

Imaginary worlds recur across hunter-gatherer narrative, suggesting that they are an ancient part of human life: to understand their popularity, we must examine their origins. Hunter-gatherer fictional narratives use various devices to encode factual information. Thus, participation in these invented worlds, born of our evolved ability to engage in pretense, may provide adaptations with information inputs that scaffold their development.

Imaginary worlds are pervasive across forager oral tradition, undermining the claim that they are a "recent striking success." Questions of popularity are difficult to quantify, since for most of its existence storytelling has been oral and is thus largely undocumented. Consequently, we do not know the degree to which imaginary worlds occur in storytelling overall, and lack a baseline for frequency comparisons. What *is* known is that (a) hunter-gatherer narrative encompasses fictional genres "typically containing some background elements that do not exist in the real world," and (b) these fictions encode factual information (Scalise Sugiyama, 2021b, 2021c).

Forager societies distinguish between tales of the recent and distant past (Scalise Sugiyama, 2017a). The former are oral histories, while the latter are set in the Distant Time, a mythical era when things occurred that are impossible today, such as shape-shifting and talking animals (Scalise Sugiyama, 2017a, 2019). This era ended as, in the course of their adventures, Distant Time beings magically transformed the world into its present state. Thus, Distant Time genres meet the authors' definition of imaginary worlds as places that "the recipients of the fiction could not have possibly explored in real life, be it … locations in the future or the distant past" (target article, sect. 2, para. 2). Significantly, Distant Time stories presage all the speculative fiction genres listed in Table 1 of the target article except uchronia.

The *fantasy* genre is evinced in stories about dragons (Wilbert & Simoneau, 1983, p. 137), mountains that grow (Opler, 1938, p. 52), and a monster (*Sniniq*) that shoots light beams from its eyes to stun its victims (McIlwraith, 1948). In its anticipation of laser technology, the *Sniniq* tale also exemplifies *science fiction*. Another case is seen when, to escape two homicidal running rocks, the Jicarilla hero Killer-of-Enemies "began to use the speed of light which the sun had promised him. The sun would throw a beam of light ahead and he would travel with it to that place" (Opler, 1938, p. 71).

The Killer-of-Enemies epic also exemplifies *adventure fiction*. Ubiquitous in forager narrative (Boas, 1898; Jobling, 2001), the hero genre typically involves journeys to unfamiliar lands and encounters with supernatural phenomena (e.g., Attla, Jones, & Thompson, 1990; Oman, 1995). Descriptions of these places provide verbal maps (Basso, 1996). For example, a hot spring inhabited by a kicking monster is sketched as follows: the "water was boiling and seething all around that place. He lay on top of a ledge beside a mountain road that wound along above the hot springs. As people passed by he kicked them into the water. [where] his four daughters lived. And all those whom he kicked in the water, these girls ate" (Opler, 1938, p. 66). Although not supplied through paratexts, such topographic sketches belie the authors' claim that *Treasure Island* features "one of the first imaginary maps" (target article, sect. 6.2, para. 2). In Killer-of-Enemies' use of supernatural abilities to combat evil we also see the *superhero* genre. The Yąnomamö child hero Õeõemë is another case: "transformed into a supernatural being" (Wilbert & Simoneau, 1990, p. 105) after being stung by ants, his powers enable him to decimate an enemy village armed only with a few arrow points.

Utopian and *dystopian* worlds are manifest in origin stories. Quinault tradition relates that Eagle wanted rivers to run in both directions, but Raven objected because "that would be too easy for the people" (Clark, 1953, p. 87). Similarly, Coyote is widely regarded as a fool whose "blundering accounts for many things in the world, especially evil" (Steward, 1936, p. 358). While the Creator is "always striving to make life easy for man," Coyote is constantly "striving to render life hard, and insisting that man must die and suffer" (Dixon, 1905, p. 336). Natural disaster myths describe *apocalyptic* and *post-apocalyptic* worlds (Ludwin et al., 2005). As a Crater Lake origin story reports: "mountains shook and crumbled. Red-hot rocks as large as the hills hurtled through the skies. Burning ashes fell like rain. The Chief of the Below World spewed fire from his mouth. Like an ocean of flame it devoured the forests on the mountains and in the valleys" (Barber & Barber, 2004, p. 6). A Toba conflagration myth begins "One day the world came to an end" because "the fire and the sulphur burned everything" until "there was nothing left in the world" (Wilbert & Simoneau, 1989, p. 83).

Forager narrative abounds with "fiction[s] in which the consumer will learn a lot of novel information" about the story world. For example, Dreamtime myths focus on the "naming of places and the movements of ancestral beings from one spot to the next. [M]any tell of journeys covering hundreds of miles of desert, through areas that Mardudjara in many cases have not seen … [and] give them a strong feeling that they know those areas" (Tonkinson, 1978, p. 89). However, as this observation indicates, imaginary worlds are not as fictional as they seem: origins are attributed to supernatural beings, but descriptions accurately map local geography (Scalise Sugiyama, 2019).

Fictional worlds also accurately map social environments. For example, although set in a world of counterfactual beings, *The Lord of the Rings* is based heavily on Anglo Saxon and Norse myth, and references the actual geography, economies, and politics of medieval and proto-industrial Northern Europe. In so doing, it provides useful comparisons of real-world economic and governance systems: The peaceful yeoman farmers of the Shire, steppe horsemen of Rohan, and woodland artisans of Rivendell are contrasted with the totalitarian industrial wasteland of Isengard. Thus, contrary to the authors' claim that they are "primarily designed for entertainment" (target article, sect. 3, para. 2) fictions are cultural inventions that illustrate possible consequences of diverse courses of action (Scalise Sugiyama, 2005, 2021b). This may provide adaptations with information inputs that scaffold their development (Tooby & Cosmides, 2001). For example, story worlds may furnish episodic memory with vicarious experiences that can be recruited for the generation of plans (Scalise Sugiyama, 2017b, 2017c).

In short, the content of fictional worlds is largely factual (Scalise Sugiyama, 2021a). Unless otherwise stipulated, pretend events are expected to unfold as they do in real life (Onishi, Baillargeon, & Leslie, 2007). For example, if a person pretends to pour water into a cup, we expect them to hold the cup beneath, not above, the pitcher, because in real life water flows downward. Similarly, we attribute normal rather than supernatural agency to the dinosaurs in *Jurassic Park*: we expect predators to attack using their teeth and claws and not by shooting laser beams from their eyes, because the latter is pretense and has not been stipulated.

This view challenges the authors' claim that there is not "any specific value in the information included" (target article, sect. 3, para. 3) in imaginary worlds. So too does the cross-cultural use of narrative devices that distinguish pretense from fact. For example, etiological animal tales – which explain how a species acquired one or more of its distinctive traits – use evidential forms, formulaic phrases, and motifs that mark them as Distant Time stories. Some devices (e.g., "they say," "long ago") encode the information that animals in the story world possess certain human traits which they lack today, while others (e.g., the transformation motif, "that is why") identify their real-world traits. In so doing, they provide information about local fauna that is far from being "totally useless in real life" (target article, sect. 3, para. 3).

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Attla, C., Jones, E., & Thompson, C. (1990). *K'etetaalkkaanee: The one who paddled among the people and animals*. Alaska Native Language Center, University of Alaska.

Barber, E. W., & Barber, P. (2004). *When they severed earth from sky: How the human mind shapes myth*. Princeton University Press.

Basso, K. (1996). *Wisdom sits in places: Landscape and language among the Western Apache*. University of New Mexico Press.

Boas, F. (1898). Introduction. In Teit, J. (Ed.), *Traditions of the Thompson River Indians of British Columbia* (pp. 1–18). Houghton, Mifflin and Company.

Clark, E. (1953). *Indian legends of the Pacific Northwest*. University of California Press.

Dixon, R. (1905). The mythology of the Shasta-Achomawi. *American Anthropologist*, *7* (4), 607–612.

Jobling, I. (2001). The psychological foundations of the hero-ogre story. *Human Nature*, *12*(3), 247–272.

Ludwin, R. S., Dennis, R., Carver, D., McMillan, A., Losey, R., Clague, J., … James, K. (2005). Dating the 1700 Cascadia earthquake; great coastal earthquakes in native stories. *Seismological Research Letters*, *76*(2), 140–148.

McIlwraith, T. F. (1948). *The Bella Coola Indians*. University of Toronto Press.

Oman, L. (1995). *The epic of Qayaq*. Carleton University Press.

Onishi, K. H., Baillargeon, R., & Leslie, A. M. (2007). 15-month-old infants detect violations in pretend scenarios. *Acta Psychologica*, *124*(1), 106–128.

Opler, M. (1938). *Myths and tales of the Jicarilla Apache Indians. Memoirs of the American Folk-lore Society, XXXI*. G.E. Stechert.

Scalise Sugiyama, M. (2005). Reverse-engineering narrative: Evidence of special design. In Gottshall, J., & Wilson, D. S. (Eds.), *The literary animal* (pp. 177–196). Northwestern University Press.

Scalise Sugiyama, M. (2017a). Distant time: A possible typological literary universal. In Hogan, P. (Ed.), *The literary universals project*. University of Connecticut. http://literary-universals.uconn.edu/2017/01/31/distant-time-a-possible-typological-literary-universal/.

Scalise Sugiyama, M. (2017b). Narrative. In Weekes-Shackelford, V., & Shackelford, T. (Eds.), *Encyclopedia of evolutionary psychological science*. Springer. https://doi.org/10.1007/978-3-319-16999-6_3316-1.

Scalise Sugiyama, M. (2017c). Oral storytelling as evidence of pedagogy in forager societies. *Frontiers in Cultural Psychology*. https://doi.org/10.3389/fpsyg.2017.00471.

Scalise Sugiyama, M. (2019). The relevance of popularity: Ecological factors at play in story pervasiveness. In Vanderbeke, D., & Cooke, B. (Eds.), *Evolution and popular narrative* (pp. 245–263). Brill Rodopi.

Scalise Sugiyama, M. (2021a). The fiction that fiction is fiction. *ASEBL Journal*, *15*, 8–12. https://resources.finalsite.net/images/v1610065663/sfc/pj4pmi0aeaffqpvyasgb/ASEBLJournalvol15January2021.pdf

Scalise Sugiyama, M. (2021b). Co-occurrence of ostensive communication and generalizable knowledge in forager storytelling: Cross-cultural evidence of teaching in forager societies. *Human Nature*, *32*(1), 279–300.

Scalise Sugiyama, M. (2021c). *Talking stories: Encyclopedia of traditional ecological knowledge*. https://talkingstories.uoregon.edu/

Steward, J. (1936). Myths of the Owens Valley Paiute. *University of California Publications in American Archaeology and Ethnology*, *34*(5), 355–440.

Tonkinson, R. (1978). *The Mardudjara aborigines: Living the dream in Australia's desert*. Holt, Rinehart and Winston.

Tooby, J., & Cosmides, L. (2001). Does beauty build adapted minds? Toward an evolutionary theory of aesthetics, fiction and the arts. *SubStance*, *30*(1/2), 6–27.

Wilbert, J., & Simoneau, K. (1983). *Folk literature of the Bororo Indians*. UCLA Latin American Center Publications, University of California, Los Angeles.

Wilbert, J., & Simoneau, K. (1989). *Folk literature of the Toba Indians*. UCLA Latin American Center Publications, University of California, Los Angeles.

Wilbert, J., & Simoneau, K. (1990). *Folk literature of the Yanomami Indians*. UCLA Latin American Center Publications, University of California, Los Angeles.

Why frightening imaginary worlds? Morbid curiosity and the learning potential of horror

Coltan Scrivner[a,b] and Mathias Clasen[c]

[a]Department of Comparative Human Development, The University of Chicago, Chicago, IL 60607, USA; [b]Institute for Minds and Biology, The University of Chicago, Chicago, IL 60607, USA and [c]Department of English, School of Communication and Culture, Aarhus University, Aarhus 8000, Denmark
cscrivner@uchicago.edu; https://coltanscrivner.com
mc@cc.au.dk; https://pure.au.dk/portal/en/persons/mathias-clasen(3c9b0961-b1e9-4084-867f-d8b959ba40e5).html

doi:10.1017/S0140525X21002259, e297

Abstract

In addition to satisfying a predisposition for exploration, fiction with imaginary worlds may also appeal to morbid curiosity, an adaptive motivation to seek out information about dangerous situations. Most imaginary worlds contain narrative elements of danger, and immersion in such worlds may provide people with information that would be costly to acquire in the real world.

Dubourg and Baumard (D&B) offer a compelling explanation for why imaginary worlds are so popular. In short, they argue that the human predisposition for exploration drives the popularity of imaginary worlds in entertainment. We offer an additional factor to supplement their argument. We argue that morbid curiosity – the motivation to gather information about dangerous situations – is a key factor in the popularity of imaginary worlds, most of which contain narrative elements of danger.

The general motivation for humans to seek out information about threatening scenarios for entertainment is a feature of morbid curiosity. Only recently has psychology begun to parse the psychological features of morbid curiosity (Oosterwijk, 2017; Scrivner, 2021a). Threat-related information in particular has a premium on our attention, spreading more often and more reliably than information that is positive, neutral, or generally negative (Blaine & Boyer, 2018). The backbone of this predisposition is an evolved system for threat negotiation (Mobbs, Hagan, Dalgleish, Silston, & Prévost, 2015). One aspect of this system is the prediction and simulation of future threats. Simulating threats through prospection can lead to improved regulation of emotions and behaviors in response to future threats by mentally rehearsing dangerous situations (Bulley, Henry, & Suddendorf, 2017).

Similar to prospection, engaging in scary play or exploring frightening imaginary worlds may also confer psychological benefits (Scrivner, Andersen, Schjoedt, & Clasen, 2021). For example, morbidly curious people and those who were fans of horror movies reported greater psychological resilience during the COVID-19 pandemic (Scrivner, Johnson, Kjeldgaard-Christiansen, & Clasen, 2021). One possible explanation for this finding is that people who explore scary fictional worlds are more practiced at encountering and dealing with anxious feelings. Indeed, Scrivner and Christensen (2021) have argued that regular engagement with scary fiction may be one avenue through which people can build and strengthen their emotion regulation skills through processes similar to those used in exposure therapy.

Morbid curiosity may also fluctuate with respect to ecological conditions. When a threat becomes more salient, it may make sense to gather information or model possible encounters through fiction. One recent example of this can be seen in the popularity of the movie *Contagion* in the early months of the COVID-19 pandemic. To the surprise of many, the nearly decade-old movie about a pandemic shot to the top of the streaming charts in the first few months of the pandemic. Why would people be streaming a movie about a pandemic during a pandemic? Scrivner (2021b) has suggested that morbid curiosity played a role in *Contagion*'s popularity during the early months of the pandemic. By watching a movie about a world where a pandemic exists, viewers were learning something about what a pandemic world is like. Moreover, those who were watching more pandemic movies at that time scored higher in morbid curiosity.

Even when stories are set in fictional or even imaginary worlds, they can offer important information. Indeed, fiction is sometimes a *better* way to spread important information about real phenomena than non-fiction because it allows for the construction of specific or unique situations that can be tailored to specific contexts (Scalise-Sugiyama, 2021). Additionally, fiction tends to foster audience immersion and emotional involvement through sympathetic engagement with characters. In other words, imaginary worlds may be worth simulating and exploring if they offer low-cost ways of learning about dangerous situations through identification with characters facing threats, and morbid curiosity is an important psychological feature that promotes this simulation and exploration (Scrivner, 2022).

Horror fiction is particularly well-suited for conveying information about danger. Clasen, Kjeldgaard-Christiansen, and Johnson (2020) have argued that horror serves the function of threat simulation, and it does so by creating virtual worlds replete with cues of danger, most prominently the danger posed by monsters or monstrous humans. While the monsters of horror typically do not exist, most horror content is psychologically and socially realistic. The characters of horror generally behave, or are expected to behave, like real people in dangerous situations (Clasen, 2017). The learning potential of horror, then, may come in the form of psychological and social insight as much as, if not more than, information about specific and ecologically relevant threats.

Though horror films are a natural home for the morbidly curious, morbid features are central to many genres of fiction, including those with imaginary worlds. Evil villains, witchcraft, and monstrous creatures are core aspects of popular fictional worlds like The Lord of the Rings and Harry Potter. These morbid features play an important role in attracting the audience's attention, creating suspense, and in the development of an interesting plot. The journey to Mordor would be much less interesting if the Fellowship did not encounter deadly trolls and bloodthirsty orcs, and Harry Potter's adventures much less interesting if he and his friends did not have to fight monstrous spiders and uncanny Dementors.

D&B's thesis explains how fiction with imaginary worlds may satisfy an evolved desire for exploration, but they say little about the contents of such fiction. We have suggested here that consideration of morbid curiosity and the learning potential of specifically frightening fiction may supplement their ideas. The prevalence of threats in fiction with imaginary worlds is no incidental feature; rather, it subserves the function of such fiction to provide threat-related information in a compelling, emotionally engaging way. The bias to attend to and spread threat-related information, which is motivated by morbid curiosity, has been shown to be an important factor in explaining recurrent features of religious systems (Boyer, 2021). Likewise, morbid curiosity is likely an important factor in explaining the recurrent features, success, and cultural evolution of imaginary worlds, the majority of which contain frightening elements.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Blaine, T., & Boyer, P. (2018). Origins of sinister rumors: A preference for threat-related material in the supply and demand of information. *Evolution and Human Behavior*, *39*(1), 67–75. https://doi.org/10.1016/j.evolhumbehav.2017.10.001.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Boyer, P. (2021). Deriving features of religions in the wild. *Human Nature*, *32*(3), 557–581. https://doi.org/10.1007/s12110-021-09410-y.
Bulley, A., Henry, J. D., & Suddendorf, T. (2017). Thinking about threats: Memory and prospection in human threat management. *Consciousness and Cognition*, *49*, 53–69. https://doi.org/10.1016/j.concog.2017.01.005.
Clasen, M. (2017). *Why horror seduces*. Oxford University Press.
Clasen, M., Kjeldgaard-Christiansen, J., & Johnson, J. A. (2020). Horror, personality, and threat simulation: A survey on the psychology of scary media. *Evolutionary Behavioral Sciences*, *14*(3), 213–230. doi: 10.1037/ebs0000152
Mobbs, D., Hagan, C. C., Dalgleish, T., Silston, B., & Prévost, C. (2015). The ecology of human fear: Survival optimization and the nervous system. *Frontiers in Neuroscience*, *9*, 55. https://doi.org/10.3389/fnins.2015.00055.
Oosterwijk, S. (2017). Choosing the negative: A behavioral demonstration of morbid curiosity. *PLoS ONE*, *12*(7), e0178399. https://doi.org/10.1371/journal.pone.0178399.
Scalise-Sugiyama, M. (2021). The fiction that fiction is fiction. *ASEBL Journal*, *15*, 8–12.
Scrivner, C. (2021a). The psychology of morbid curiosity: Development and initial validation of the morbid curiosity scale. *Personality and Individual Differences*, *183*, 111139. https://doi.org/10.1016/j.paid.2021.111139.
Scrivner, C. (2021b). An infectious curiosity: Morbid curiosity and media preferences during a pandemic. *Evolutionary Studies in Imaginative Culture*, *5*(1), 1–12. https://doi.org/10.26613/esic.5.1.206.
Scrivner, C. (2022). Curiosity: A behavioral biology perspective. *PsyArXiv*. https://doi.org/10.31234/osf.io/rqa5b.
Scrivner, C., & Christensen, K. A. (2021). Scaring away anxiety: Therapeutic avenues for horror fiction to enhance treatment for anxiety symptoms. https://psyarxiv.com/7uh6f/.
Scrivner, C., Andersen, M. M., Schjoedt, U., & Clasen, M. (2021). The psychological benefits of scary play in three types of horror fans. https://doi.org/10.31234/osf.io/sdxe6.
Scrivner, C., Johnson, J. A., Kjeldgaard-Christiansen, J., & Clasen, M. (2021). Pandemic practice: Horror fans and morbidly curious individuals are more psychologically resilient during the COVID-19 pandemic. *Personality and Individual Differences*, *168*, 110397. https://doi.org/10.1016/j.paid.2020.110397.

The familiar appeal of imaginary worlds

Andrew Shtulman

Department of Psychology, Occidental College, Los Angeles, CA 90041, USA
shtulman@oxy.edu

doi:10.1017/S0140525X21002338, e298

Abstract

Imaginary worlds may satisfy our need to explore, but it's an open question what we are searching for. Research on imagination suggests that if we are searching for something extraordinary – something that violates our intuitions about real-world causality – then we seek it in small doses and in contexts that ultimately confirm our intuitions. Imaginary worlds allow for true novelty, but we may actually prefer ideas that are novel on their surface but familiar at their core.

The wizarding world of Harry Potter is one of the most popular imaginary worlds of all time. Every year millions of people read the Harry Potter novels and watch the Harry Potter movies, but what draws them to this world? Is it the magic spells, like levitation and transfiguration, and fantastical creatures, like hippogriffs and house elves? Or is it the characters, like Ron and Hermione, and their experiences at boarding school, like going to dances and confronting difficult teachers? Are people drawn to Harry Potter's world for its physical impossibilities or its fictional versions of familiar realities?

Dubourg and Baumard (D&B) argue that humans engage with imaginary worlds because these worlds provide an outlet for novelty-seeking. Humans, like other animals, must forage for resources, and we prefer to do so in novel environments, whose resources have yet to be discovered. Imaginary worlds satisfy our desire to forage in novel environments because they contain resources we could not, by definition, have encountered in the real world.

While this analogy between foraging and fiction is intriguing, it entails a tension in the meaning of "novel." We forage for novel sustenance, not novel resources. We seek resources that are familiar but must be consumed anew: a new bite of familiar food, a new burrow in familiar terrain. Imaginary worlds contain all manners of novelty – talking animals, flying carpets, time-traveling wizards, flesh-eating zombies – but these extreme cases may not be what draws us to imaginary worlds. We may be seeking novel instances of familiar experiences, such as courtship or politics, which, if true, renders many of the imaginary aspects of imaginary worlds moot. As D&B note, fans of Harry Potter often forage for Quidditch rules; fans of Star Wars forage for planet names; and fans of Pokémon forage for family trees. We forage for ideas that are familiar and easy to understand.

Support for this contention comes from research on how we process ideas that are not easy to understand – ideas that violate core intuitions about real-world causality. Such ideas tend to be memorable, but they become less memorable the more intuitions they violate (Boyer & Ramble, 2001). Stories that include counterintuitive ideas follow this same pattern; a few counterintuitive ideas make a story memorable but too many make it incomprehensible, as illustrated by the success of the Grimm Brothers' *Cinderella* but lack of success of their bizarre tale *The Girl Without Hands* (Norenzayan, Atran, Faulkner, & Schaller, 2006). Moreover, when we read narratives that violate real-world regularities, like fairytales, we assume that other real-world regularities still hold, especially mathematical and scientific ones (Weisberg & Goodstein, 2009). Counterintuitive ideas are appealing only against a backdrop of intuitive ones.

Even counterintuitive ideas themselves follow an intuitive logic. When a story involves a magical transformation, animate entities tend to turn into other animate entities, such as people turning into pigs, but inanimate entities tend to remain inanimate, such as tears turning into streams (Kelly & Keil, 1985). When a story involves magical spells, some spells are depicted as more difficult than others, and their ordering accords with our intuitions about the physical laws violated by the spells. The more foundational the law, the more difficult we view the spell, as reflected by the intuition that conjuring a frog out of thin air is more difficult than changing a frog's color (McCoy & Ullman, 2019). Likewise, laws appreciated early in development, such as object permanence and object cohesion, are viewed as more difficult to violate than laws appreciated later in development, such as gravity and inertia (Lewry, Curtis, Vasilyeva, Xu, & Griffiths, 2021).

Intuitions about spell difficulty also honor the multiplicity of expectations we bring to bear on real-world events. Lifting an object, for instance, elicits the expectation that heavy objects are harder to lift, as well as the expectation that physical support must be applied. When we read stories that involve levitation spells, we hold the second expectation in abeyance but not the first; we grant characters the power to lift objects without

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

physically supporting them, but we still expect that heavy objects, like a bowling ball, will be more difficult to levitate than lighter ones, like a basketball (Shtulman & Morgan, 2017). Weight is ostensibly irrelevant in a world that severs the connection between lifting and support, but we apply this consideration nonetheless. Indeed, we apply irrelevant causal considerations when reasoning about any type of magic, regardless of age or cultural upbringing (Gong & Shtulman, 2021).

Such findings indicate that our beliefs about magical events – events that occur only in imaginary worlds – are highly constrained by our beliefs about real-world causality (Harris, 2021). When we engage with imaginary worlds, we appear to be less concerned with learning new ideas and more concerned with applying the ideas we already know. If what we seek in imaginary worlds is true novelty, then we would likely learn to search elsewhere. We would eschew fantasy books and superhero movies for classes on quantum mechanics and differential equations. Science and mathematics involve ideas that have no familiar precursors; they defy intuition and are thus truly novel from a conceptual perspective (Shtulman, 2017). Yet, rather than devote ourselves to learning evolutionary biology or celestial mechanics, most people would prefer to spend their time assimilating the mundane details of imaginary worlds, like the ancestries of Pokémon characters or the names of Star Wars planets.

D&B rightly note that imaginary worlds are a "super stimulus," intentionally crafted to grab attention, because they satisfy our need to explore, but it's an open question what we are searching for. Research on imagination suggests that if we are searching for something counterintuitive – something that violates our intuitions about real-world causality – then we seek it in small doses and in contexts that ultimately confirm our intuitions on the whole. Imaginary worlds allow for the truly novel, but true novelty may not be all that enjoyable. We may actually prefer novel versions of entities and events that are, at their core, completely familiar.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Boyer, P., & Ramble, C. (2001). Cognitive templates for religious concepts: Cross-cultural evidence for recall of counter-intuitive representations. *Cognitive Science*, *25*, 535–564.

Gong, T., & Shtulman, A. (2021). The plausible impossible: Chinese adults hold graded notions of impossibility. *Journal of Cognition and Culture*, *21*, 76–93.

Harris, P. L. (2021). Early constraints on imagination: The realism of young children. *Child Development*, *92*, 466–483.

Kelly, M. H., & Keil, F. C. (1985). The more things change…: Metamorphoses and conceptual structure. *Cognitive Science*, *9*, 403–416.

Lewry, C., Curtis, K., Vasilyeva, N., Xu, F., & Griffiths, T. L. (2021). Intuitions about magic track the development of intuitive physics. *Cognition*, *214*, 104762.

McCoy, J., & Ullman, T. (2019). Judgments of effort for magical violations of intuitive physics. *PLoS ONE*, *14*, e0217513.

Norenzayan, A., Atran, S., Faulkner, J., & Schaller, M. (2006). Memory and mystery: The cultural selection of minimally counterintuitive narratives. *Cognitive Science*, *30*, 531–553.

Shtulman, A. (2017). *Scienceblind: Why our intuitive theories about the world are so often wrong*. Basic Books.

Shtulman, A., & Morgan, C. (2017). The explanatory structure of unexplainable events: Causal constraints on magical reasoning. *Psychonomic Bulletin & Review*, *24*, 1573–1585.

Weisberg, D. S., & Goodstein, J. (2009). What belongs in a fictional world. *Journal of Cognition and Culture*, *9*, 69–78.

Does progressive aphantasia exist? The hypothetical role of aphantasia in the diagnosis of neurodegenerative diseases

Emilia J. Sitek[a,b] and Seweryna Konieczna[c,d]

[a]Division of Neurological and Psychiatric Nursing, Faculty of Health Sciences, Medical University of Gdansk, 80-210 Gdansk, Poland; [b]Department of Neurology, St. Adalbert Hospital, Copernicus Ltd., 80-462 Gdansk, Poland; [c]Department of History and Philosophy of Medical Sciences, Faculty of Health Sciences, Medical University of Gdansk, 80-210 Gdansk, Poland and [d]Department of Developmental Neurology, University Medical Center, Medical University of Gdańsk, 80-210 Gdańsk, Poland
emilia.sitek@gumed.edu.pl
seweryna.konieczna@gumed.edu.pl

doi:10.1017/S0140525X21002375, e299

Abstract

Aphantasia is a heterogeneous neuropsychological syndrome consisting of the inability to create mental images. We argue that its progressive form may be a harbinger of dementia. Aphantasia may manifest as the inability to create any mental images or to create complex scenes, inability to spontaneously initiate generation of mental images, and/or inability to visualize a sequence of events.

Terry Pratchett (1948–2015), fantasy writer, affected in later life by posterior cortical atrophy (PCA), visual variant of Alzheimer's disease, claimed that "*Stories of imagination tend to upset those without one*." While, engagement into imaginary worlds is a very rewarding experience for individuals with high openness to experience and novelty preference as emphasized by Dubourg and Baumard (D&B) and the experience of imagery may be regarded on a continuum from hyperphantasia to aphantasia. Hyperphantasia is related to creativity (Zeman et al., 2020). Aphantasia, a clinical syndrome consisting of the inability to create mental "images" is sometimes associated with face recognition deficits and autism spectrum traits (Milton et al., 2021). Voluntary mental imagery is a complex top-down process initiated in the frontal cortex that triggers stored information/memory traces from posterior brain areas (Goodale & Milner, 1992; Goodale & Westwood, 2004). We argue that change in preference for imaginary worlds may be related to cognitive or personality changes in the course of a neurodegenerative disease. The discussion on the engagement into the imaginary worlds seems to have clinical implications for dementia, while till now aphantasia has been described mainly in focal brain damage (Zeman et al., 2010) or as a congenital disorder (Zeman, Dewar, & Della Sala, 2015). We hypothesize that change in preference for imaginary worlds could be a clinically relevant phenomenon, potentially helpful in neurological diagnosis or patient monitoring.

Although Galton noted high variability of mental imagery in 1880 (Galton, 1880), the first case of impaired imagery was described from neurological perspective by Charcot and Bernard in 1883 (Zago et al., 2011). Monsieur X complained that he suddenly lost mental imagery, not only was he unable

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

to form mental images but also noticed its emotional implications (see Young & Wal, 1996).

D&B discuss individual differences in novelty preferences and interest in imaginary worlds. Could these individual differences be relevant also for neuropsychological characteristics of dementia syndromes? Reading/watching fictions or playing computer games including imaginary worlds engages a variety of cognitive functions. As D&B noted discussing the example of *No Man's Sky* (2016) the preference for a complex (but not too complex) imaginary world may be associated with human cognitive limitations. Are progressive neurodegenerative disorders are also associated with reduced preference for imaginary worlds due to cognitive deficits? While reading a fictional narrative healthy individuals use visualizing (Brosch, 2018). Although reading aloud may be, except for PCA, relatively well preserved until late in the course of dementia, people with dementia usually read less or stop reading fiction novels because of the failure to concentrate and/or track the plot (Clement, Belleville, & Gauthier, 2008).

Focal cognitive deficits, such as acalculia (Mendez, Moheb, Desarzant, & Teng, 2018) or prosopagnosia (Evans, Heggs, Antoun, & Hodges, 1995), may be a harbinger of dementia. Scopus search [TITLE-ABS-KEY (aphantasia) AND TITLE-ABS-KEY (dementia OR Alzheimer OR progressive OR neurodegenerative)] conducted on September 24, 2021 failed to identify any link between aphantasia and dementia. We hypothesize that four different types of progressive aphantasia could be a harbinger of dementia:

We assume that apperceptive and associative aphantasia (named after apperceptive and associative agnosia and prosopagnosia) would be related to posterior brain dysfunction and could be a harbinger of PCA. On the contrary, ideational (inability to visualize a sequence of scenes) and adynamic aphantasia (inability to initiate the mental image) would be associated with frontal/fronto-striatal dysfunction and could be an early symptom of frontotemporal dementia, progressive supranuclear palsy (PSP), or Huntington's disease (HD).

Although, literature lacks in studies providing direct support for our hypotheses, there is scarce data somewhat consistent with our predictions. In PCA visual imagery deficits lead to poor scene construction (Ramanan et al., 2018), which would correspond to associative aphantasia. Spatial integration of the scene engages not only parietal areas, but also the right hippocampus, and it is affected also in frontotemporal dementia (Wilson et al, 2020).

In PSP generation (Robinson, Spooner, & Harrison, 2015) and/or sequencing of novel thought (Robinson, 2013) may be significantly deficient. The former could be associated with adynamic aphantasia, while the latter with ideational aphantasia. Both seem closely related to executive dysfunction. It is open to debate if social cognition and decision-making deficits in the early phases of HD (Mason, Schaepers, & Barker, 2021) could also be related to some extent to aphantasia, as efficient decision-making may involve imagining future outcome (Nanay, 2016).

On the other hand, D&B emphasize the relationship between engagement into imaginary worlds and novelty preference as well as openness to experience. Engagement into imaginary world may be a potential reward source for individuals with high novelty preference. Parkinson's disease (PD) has been associated with low novelty seeking (Cerasa, 2018) and low openness to experience (Santangelo et al., 2018). Of note, dopaminergic treatment in PD may promote creativity (Garcia-Ruiz, Martinez Castrillo, & Desojo, 2019), as striatal dopamine is related to flexible creative processes and prefrontal dopamine to persistence-driven creativity (Boot, Baas, van Gaal, Cools, & De Dreu, 2017). However, dopaminergic treatment may also lead to impulse control disorders (ICD). Could dopamine replacement therapy influence aphantasia? Could it provoke a sudden interest in the imaginary worlds?

Aphantasia in the field of neurodegenerative disease remains largely an undiscovered land. Openness to experience, as a personality trait, may be a protective factor against cognitive decline (Rodriguez et al., 2016) as is cognitive activity (including reading) (Floud et al., 2021). If openness to experience is associated with a preference for imaginary worlds, does behavioral engagement into imaginary worlds promote cognitive health in later life? Should we incorporate questions about literary preferences to interviews at dementia clinics? Also, as playing computer games compulsively may be a symptom of ICD in PD, should we study patients' game preferences in the future? Would we identify individuals with high risk of developing ICD among lovers of imaginary worlds? Is mesolimbic dopaminergic pathway activity, implicated in PD, also associated with preference for imaginary worlds?

Funding. None.

Conflict of interest. None.

References

Boot, N., Baas, M., van Gaal, S., Cools, R., & De Dreu, C. (2017). Creative cognition and dopaminergic modulation of fronto-striatal networks: Integrative review and research agenda. *Neuroscience and Biobehavioral Reviews*, *78*, 13–23. doi: doi.org/10.1016/j.neubiorev.2017.04.007

Brosch, R. (2018). What we "see" when we read: Visualization and vividness in reading fictional narratives. *Cortex*, *105*, 135–143. doi: doi.org/10.1016/j.cortex.2017.08.020

Cerasa, A. (2018). Re-examining the Parkinsonian personality hypothesis: A systematic review. *Personality and Individual Differences*, *130*, 41–50.

Clément, F., Belleville, S., & Gauthier, S. (2008). Cognitive complaint in mild cognitive impairment and Alzheimer's disease. *Journal of the International Neuropsychological Society: JINS*, *14*(2), 222–232. doi: doi.org/10.1017/S1355617708080260

Evans, J. J., Heggs, A. J., Antoun, N., & Hodges, J. R. (1995). Progressive prosopagnosia associated with selective right temporal lobe atrophy. A new syndrome? *Brain*, *118*(Pt 1), 1–13. doi: doi.org/10.1093/brain/118.1.1

Floud, S., Balkwill, A., Sweetland, S., Brown, A., Reus, E. M., Hofman, A., … Beral, V. (2021). Cognitive and social activities and long-term dementia risk: The prospective UK Million Women Study. *The Lancet Public Health*, *6*(2), e116–e123. doi: doi.org/10.1016/S2468-2667(20)30284-X

Galton, F. (1880). Statistics of mental imagery. *Mind*, *19*, 301–318. doi: doi.org/10.1093/mind/os-V.19.301

Garcia-Ruiz, P. J., Martinez Castrillo, J. C., & Desojo, L. V. (2019). Creativity related to dopaminergic treatment: A multicenter study. *Parkinsonism & Related Disorders*, *63*, 169–173. doi: doi.org/10.1016/j.parkreldis.2019.02.010

Goodale, M. A., & Milner, A. D. (1992). Separate visual pathways for perception and action. *Trends in Neurosciences*, *15*(1), 20–25. doi: doi.org/10.1016/0166-2236(92)90344-8

Goodale, M. A., & Westwood, D. A. (2004). An evolving view of duplex vision: Separate but interacting cortical pathways for perception and action. *Current Opinion in Neurobiology*, *14*(2), 203–211. doi: doi.org/10.1016/j.conb.2004.03.002

Mason, S. L., Schaepers, M., & Barker, R. A. (2021). Problems with social cognition and decision-making in Huntington's disease: Why is it important? *Brain Sciences*, *11*(7), 838. doi: doi.org/10.3390/brainsci11070838

Mendez, M. F., Moheb, N., Desarzant, R. E., & Teng, E. H. (2018). The progressive acalculia presentation of parietal variant Alzheimer's disease. *Journal of Alzheimer's Disease: JAD*, *63*(3), 941–948. doi: doi.org/10.3233/JAD-180024

Milton, F., Fulford, J., Dance, C., Gaddum, J., Heuerman-Williamson, B., Jones, K., … Zeman, A. (2021). Behavioral and neural signatures of visual imagery vividness extremes: Aphantasia versus hyperphantasia. *Cerebral Cortex Communications*, *2*(2), tgab035. doi: doi.org/10.1093/texcom/tgab035

Nanay, B. (2016). The role of imagination in decision-making. *Mind & Language*, *31*, 127–143. doi: doi.org/10.1111/mila.12097

Ramanan, S., Alaeddin, S., Goldberg, Z. L., Strikwerda-Brown, C., Hodges, J. R., & Irish, M. (2018). Exploring the contribution of visual imagery to scene construction –

evidence from posterior cortical atrophy. *Cortex*, *106*, 261–274. doi: doi.org/10.1016/j.cortex.2018.06.016

Robinson, G. A. (2013). Primary progressive dynamic aphasia and parkinsonism: Generation, selection and sequencing deficits. *Neuropsychologia*, *51*(13), 2534–2547. doi: doi.org/10.1016/j.neuropsychologia.2013.09.038

Robinson, G. A., Spooner, D., & Harrison, W. J. (2015). Frontal dynamic aphasia in progressive supranuclear palsy: Distinguishing between generation and fluent sequencing of novel thoughts. *Neuropsychologia*, *77*, 62–75. doi: doi.org/10.1016/j.neuropsychologia.2015.08.001

Rodriguez, C., Albanese, E., Pegna, A., Toma, S., Ackermann, M., Tombeur, E., … Giannakopoulos, P. (2016). Personality-related determinants of subtle cognitive decline in old age: A population-based study. *Dementia and Geriatric Cognitive Disorders Extra*, *6*(1), 120–1322016. doi: doi.org/10.1159/000441388

Santangelo, G., Garramone, F., Baiano, C., D'Iorio, A., Piscopo, F., Raimo, S., & Vitale, C. (2018). Personality and Parkinson's disease: A meta-analysis. *Parkinsonism & Related Disorders*, *49*, 67–74.

Wilson, N. A., Ramanan, S., Roquet, D., Goldberg, Z. L., Hodges, J. R., Piguet, O., & Irish, M. (2020). Scene construction impairments in frontotemporal dementia: Evidence for a primary hippocampal contribution. *Neuropsychologia*, *137*, 107327. doi: doi.org/10.1016/j.neuropsychologia.2019.107327

Young, A. W., & Wal, A. W. (1996). Charcot's case of impaired imagery. In Chris Code, Claus-W. Wallesch, Yves Joannette & Andre Roch Lecours (Eds.), *Classic cases in neuropsychology* (Vol. I, pp. 31–44). Psychology Press.

Zago, S., Allegri, N., Cristoffanini, M., Ferrucci, R., Porta, M., & Priori, A. (2011). Is the Charcot and Bernard case (1883) of loss of visual imagery really based on neurological impairment? *Cognitive Neuropsychiatry*, *16*(6), 481–504. doi: doi.org/10.1080/13546805.2011.556024

Zeman, A. Z., Della Sala, S., Torrens, L. A., Gountouna, V. E., McGonigle, D. J., & Logie, R. H. (2010). Loss of imagery phenomenology with intact visuo-spatial task performance: A case of "blind imagination". *Neuropsychologia*, *48*, 145–155. doi: 10.1016/j.neuropsychologia.2009.08.024

Zeman, A., Dewar, M., & Della Sala, S. (2015). Lives without imagery – congenital aphantasia. *Cortex*, *73*, 378–380. doi: doi.org/10.1016/j.cortex.2015.05.019

Zeman, A., Milton, F., Della Sala, S., Dewar, M., Frayling, T., Gaddum, J., … Winlove, C. (2020). Phantasia – The psychological significance of lifelong visual imagery vividness extremes. *Cortex*, *130*, 426–440. doi: doi.org/10.1016/j.cortex.2020.04.003

How granular should our explanations of fantastic fiction be?

Oleg Sobchuk

Minds and Traditions Research Group, Max Planck Institute for the Science of Human History, 07745 Jena, Germany
sobchuk@shh.mpg.de
https://www.shh.mpg.de/person/98794/25522

doi:10.1017/S0140525X21002326, e300

Abstract

Explaining the reasons behind the success of various kinds of fiction is important, but how granular should our explanations be? I suggest that using a less granular, more general hypothesis would allow avoiding some pitfalls, such as using the concept of "imaginary world," which eludes precise definitions.

In their thought-provoking article, Dubourg and Baumard (D&B) suggest that the popularity of "imaginary worlds" in books, films, and video games is explained by an evolved preference for the exploration of new environments. I sympathize with their intention to offer a testable hypothesis about the cultural evolution of fiction: As I argued earlier (Sobchuk, 2018), this research area deserves more attention than it currently gets. And yet I want to challenge three points of the paper: (1) I doubt that an "imaginary world" is a clearly defined concept; (2) I am not sure that "imaginary world" fiction is as popular as the authors claim; (3) most importantly, I can think of alternative explanations of "imaginary worlds," which can be more compelling due to their generalizability across a wider array of phenomena.

First, the concept. The phrase "imaginary world" may sound intuitive, but if we look closer at its definition, we'll see that it has blurry edges. The definition: "Imaginary worlds are fictional environments that the recipients of the fiction could not have possibly explored in the real life, be it far removed islands, locations in the future or the distant past, other planets, or environments in alternative history" (target article, sect. 2, para. 2). Broad! Yet most examples in the paper come from very specific genres: fantasy and science fiction. According to the authors, Tolkien's *The Lord of the Rings* does depict an imaginary world, while Balzac's *The Human Comedy* doesn't. But why not? From a modern reader's view, it is located in "distant past" – so remote and unusual that it may be easily perceived as "alternative history." Plus, the multivolume fictional world of Balzac includes at least one fantastic story, *The Skin of Shagreen*. Does a single fantastic element make *The Human Comedy* as a whole "imaginary"? And how inaccessible, exactly, shall a fictional world be to become "imaginary"?

Answering this question is important if we think that some narratives are appealing because they are set in an "imaginary world." D&B certainly do. The opening sentence of the paper: "The world around fictions with imaginary worlds draw acclaim from the public, the critics and the industry, making them both best-selling and most-appreciated fictions (e.g., top-ranked in online ranking websites)" (target article, sect. 1, para. 1). The target article makes it sound as if science fiction and fantasy (clearly, the backbone of the "imaginary world" concept) are *the* most popular genres of fiction. Are they? The analysis of the New York Times bestseller lists (Yucesoy, Wang, Huang, & Barabási, 2018) shows that the most profitable genres of fiction are, in descending order, general fiction, suspense/thrillers, mystery/detective, romance, and only then, on places 5 and 6, fantasy and science fiction. Even in the English-speaking world, the citadel of sci-fi and fantasy, they are far from being the most "best-selling and most-appreciated."

Still, fantasy and science fiction are popular; why? D&B: "Our hypothesis is that the cultural preference for imaginary worlds relies on our exploratory preferences, driving our motivation to explore novel environments" (target article, sect. 4, para. 1). The authors avoid the common "fiction is an adaptive simulation" argument, which we have tested and found little support for (Morin, Acerbi, & Sobchuk, 2019). Instead, they say: "Imaginary worlds, we propose, are appealing because they meet the 'input conditions' of our cognitive dispositions geared toward exploration" (target article, sect. 3, para. 3). Thus, my question: how *granular* are these cognitive dispositions?

Let's consider the spectrum of cognitivist explanations for the popularity of fantasy and science fiction, on Figure 1. Do humans have an adaptive preference for these particular genres? Of course not. Then, do we have a more general adaptation to appreciate fiction? Some – for example, the scholars from the literary Darwinism camp – would say "yes," but not D&B. Their answer is placed further along the spectrum: humans have adaptation for *spatial* exploration, and some books, films, or video games tap into it. Myself, I would move even further. The appeal of the fantastic stories can easily be a special case of the general hedonic appeal of information that is *unusual but not too unusual*. Since Berlyne's (1970) experiments, it is known that humans enjoy stimuli that hit the sweet spot between novelty and

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

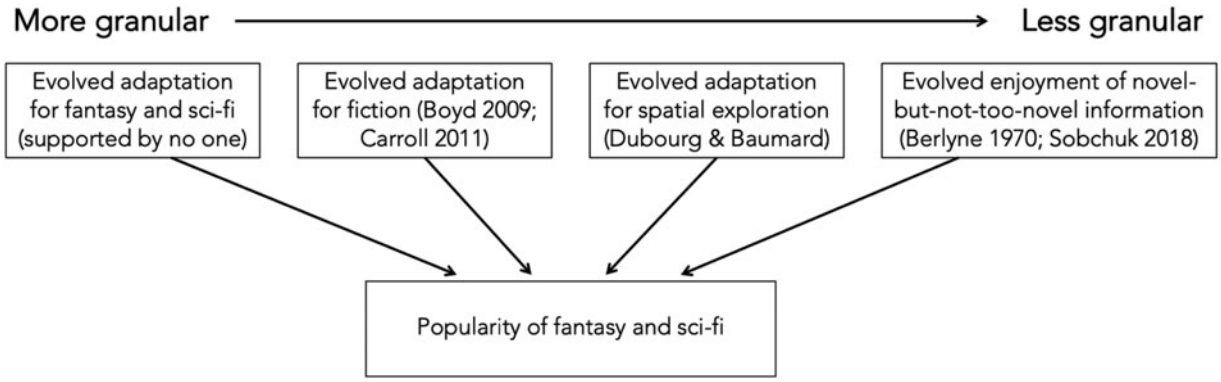

Figure 1. (Sobchuk). Possible cognitive explanations of fantasy and science fiction, ordered from the most to the least granular. (Of course, cognition is one of many factors influencing the success of stories: the actual causal graph of fiction's success should be much more complex.)

comprehensibility (see also Berger & Packard, 2018; Silvia, 2006; Tran, Waring, Atmaca, & Beheim, 2021). We enjoy stimuli that depart from our everyday experience, but if they depart too much, they become too complex to be enjoyed. Fantasy and science fiction fit this explanation. In fantasy genre, where an author's imagination should be unlimited, the depicted environments are in fact highly restricted; they are creative departures from the environment most readers know well from history lessons or TV: the Middle Ages (and, historically, medieval chivalric novels are one strong influence on modern fantasy genre). The same is true for science fiction, with its human-like aliens and distant planets covered with Earth-like forests, deserts, and oceans. They are unusual, but firmly grounded in our common knowledge. Novel, but not too novel.

Is this, more general, explanation stronger than the one suggested by D&B? Only carefully designed empirical tests can tell. However, I already see an immediate benefit of having a more general explanation: it does not require the new concept of "imaginary world," which is hard to define. This more general explanation can be used to explain not only interesting spatial worlds, but also abstract images, music, architecture, and other artistic phenomena.

Funding. None.

Conflict of interest. None.

References

Berger, J., & Packard, G. (2018). Are atypical things more popular? *Psychological Science*, *29*(7), 1178–1184.

Berlyne, D. E. (1970). Novelty, complexity, and hedonic value. *Perception & Psychophysics*, *8*, 279–286.

Boyd, B. (2009). *On the origin of stories: Evolution, cognition, and fiction*. Belknap Press.

Carroll, J. (2011). *Reading human nature: Literary Darwinism in theory and practice*. State University of New York Press.

Morin, O., Acerbi, A., & Sobchuk, O. (2019). Why people die in novels: Testing the ordeal simulation hypothesis. *Palgrave Communications*, *5*, 62.

Silvia, P. J. (2006). *Exploring the psychology of interest*. Oxford University Press.

Sobchuk, O. (2018). *Charting artistic evolution: An essay in theory*. University of Tartu Press.

Tran, N. H., Waring, T., Atmaca, S., & Beheim, B. A. (2021). Entropy trade-offs in artistic design: A case study of Tamil *kolam*. *Evolutionary Human Sciences*, *3*, e23.

Yucesoy, B., Wang, X., Huang, J., & Barabási, A.-L. (2018). Success in books: A big data approach to bestsellers. *EPJ Data Science*, *7*, 7.

Imaginary worlds are attractive because they simulate multiple adaptive problems and encode real-world information

Lawrence Sugiyama

Anthropology Department, University of Oregon, Eugene, OR 97403, USA
sugiyama@uoregon.edu

doi:10.1017/S0140525X21002399, e301

Abstract

Organisms don't explore for exploration's sake: exploratory psychology is regulated by inputs from multiple adaptations dedicated to processing information from different domains of ancestral adaptive relevance. As holistic representations of environments, imaginary worlds simulate multiple adaptive problems, solutions, and outcomes, thereby engaging numerous emotional systems and providing potentially useful information. Their popularity is thus best understood in terms of the full spectrum of information domains they comprise.

Imaginary worlds are ubiquitous in forager narrative, suggesting deep-seated evolutionary appeal (Scalise Sugiyama, 2017a, 2021; Wiessner, 2014). Thus, questions of their popularity begin with past environments: why did our ancestors produce and consume such fictions? While fictional worlds likely "co-opt our preferences for exploration" (target article, abstract), the authors mischaracterize these preferences as content-agnostic motivations operating in the absence of immediate payoff. This underplays the regulatory inputs that shape exploratory behavior, leading to the mistaken conclusion that imaginary worlds lack adaptively useful information.

Preferences and attractions are species-, content-, and context-specific (e.g., Sugiyama, 2015). Organisms are continually presented with novelty across multiple physical scales, not all of which is equally relevant to fitness (e.g., a rapidly approaching

agent vs. dust motes). The problem of computational explosion requires mechanisms that channel attention to cues of adaptive problems and their solutions, activate appropriate processing mechanisms, and coordinate responses via superordinate programs (e.g., emotions) that upregulate certain processes while downregulating others (Cosmides & Tooby, 2000; Tooby & Cosmides, 1990, 1992; Tooby, Cosmides, Sell, Lieberman, & Sznycer, 2008). Preferences that were not regulated by inputs from adaptations that assess the net probable value of engaging in a given exploration would not be functional and would not evolve.

Responses to novelty are not always feelings of pleasure and attraction. When released into novel, empty enclosures, zebrafish exhibit particular spatial and temporal exploratory patterns, including preferences for perimeter zones in apparent attempts to escape, light versus dark zones, and establishment of a home base (e.g., Blaser, Chadwick & McGinnis, 2010; Blaser & Rosemberg, 2012; Champagne, Hoefnagels, De Kloet, & Richardson, 2010; Eilam & Golani, 1989; Stewart et al., 2010, 2012). Rats, humans, and other organisms similarly exhibit distinctive exploratory patterns (e.g., Drai, Benjamini, & Golani, 2000; Gagnon, Cashdan, Stefanucci, & Creem-Regehr, 2016, 2018; Huang, Kerman, Sieving, & Mary, 2016; Thompson, Berkowitz & Clark, 2018), and different investigatory and ranging behavior in response to different environmental cues (e.g., Schaffer et al., 2020; Schloegl, Kotrschal, & Bugnyar, 2007; Shepherd, 2010). Additionally, responses to novelty cease more or less quickly depending on the species and features in question (e.g., Deecke, Slater, & Ford, 2002; Epstein, Temple, Roemmich, & Bouton, 2009; Kalueff, 2006).

Humans attend to specific cues of habitat quality (Beckerman, 1983; Orians & Heerwagen, 1992) which regulate exploratory behavior. This task is scaffolded by adaptations for creating and deploying cognitive maps, dead reckoning, route integration, and landmark/object location memory, with individual, sex, and cross-cultural variation in preferences for and effectiveness of different strategies, depending on goals, developmental environment, and ecological conditions (e.g., Cashdan & Gaulin, 2016; Davis et al., 2019; Gagnon et al., 2018; Trumble et al., 2016). Twe and Tjimba men with better spatial abilities travel farther, and have more offspring than peers (Vashro & Cashdan, 2015). Hadza men travel farther, explore more territory, and take more sinuous routes than Hadza women, in line with sexual division of labor (Wood et al., 2021). Hadza, Twe, and Tjimaba range further than neo-tropical forager-horticulturalists, consonant with differences in resource distribution and subsistence (Cashdan, Marlowe, Crittenden, Porter, & Wood, 2012). Information on resource location and quality is used in later foraging (e.g., Beckerman, 1983), and dead reckoning accuracy to object location increases linearly with the caloric value of resources (New, Krasnow, Truxaw, & Gaulin, 2007). Pursuit of prey is regulated by the relative probable value of continuing to search for all higher-value targets based on prior experience (e.g., Alvard, 1993; Hawkes, Hill, & O'Connell, 1982; Hill, Kaplan, Hawkes, & Hurtado, 1987; Janssen & Hill, 2014), and search patterns are conditional upon prey encounters in real time (Ross & Winterhalder, 2018).

Exploratory behavior is thus regulated by adaptations that assess specific informational cues, including for later use (e.g., Beckerman, 1983). For humans, these include agents (e.g., prey, predators, enemies, kin, allies, mates), novel technologies, material resources, and topographic features such as ingress and escape routes, ambush and attack zones, and refuge and cover. These stimuli engage attention and arouse emotion because they serve as inputs to adaptations that assess threats and opportunities that recurrently impacted fitness in ancestral environments. As holistic representations of environments, agents, and events (Scalise Sugiyama, 2009, 2017b), imaginary worlds simulate these cues and their associated fitness constraints and affordances. Fictional narrative teems with representations of adaptive problems, such as wayfinding predator evasion, hunting, warfare, cheater detection, mating, and childcare (Scalise Sugiyama, 2004, 2008a, 2008b, 2011, 2019; Scalise Sugiyama & Sugiyama, 2009, 2011). As story characters grapple with these problems, the audience acquires information about the outcomes of the strategies deployed in response to them (Scalise Sugiyama, 2008a; Scalise Sugiyama & Sugiyama, 2009).

Thus, imaginary worlds are attractive because they simulate multiple adaptive problems and their associated cues, thereby engaging multiple suites of adaptations concurrently. In so doing, they offer the same promise as accounts of unfamiliar actual worlds: the opportunity to acquire knowledge "when the pressure is off … [that] may well be useful at another time" (Blurton Jones & Konner, 1976, p. 344). We are motivated to engage in these worlds not because they offer "lots of new information" per se, but because they offer potential fitness payoffs in the form of adaptively relevant information that might be useful in real life.

Peter Jackson's adaptation of the *Lord of the Rings* trilogy is a case in point. Middle-earth brims with real-world cues of dangerous or inhospitable terrain: precipitous mountain passes, avalanches, caves, swamps, lava fields, volcanoes, and deforestation. Animate threats abound: the Nazgûl, Balrog, Orks, Uruk-hai, Shelab, Gollum, Grima Wormtongue, Saruman, and Sauron. Although imaginary, these agents embody cues to real-world dangers: predation, warfare, environmental degradation, betrayal, deceit, greed, tyranny, and genocide. As the Fellowship attempts to surmount these obstacles, the audience observes their tactics and technologies, and why they succeed or fail. In the course of their struggles, the characters model social values such as courage, loyalty, and perseverance against long odds. Those who are skeptical that imaginary worlds can impart practical knowledge need to look no further than Samwise Gamgee: when headed for unfamiliar lands, take a pot, a blade, a light, a rope, emergency rations, and, if possible, a steadfast friend.

Funding statement. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Alvard, M. S. (1993). Testing the "ecologically noble savage" hypothesis: Interspecific prey choice by Piro hunters of Amazonian Peru. *Human Ecology*, *21*(4), 355–387.

Beckerman, S. (1983). Carpe diem: An optimal foraging approach to Bari fishing and hunting. *Adaptive responses of native Amazonians* (pp. 269–299). Academic Press.

Blaser, R. E., Chadwick, L., & McGinnis, G. C. (2010). Behavioral measures of anxiety in zebrafish (*Danio rerio*). *Behavioural Brain Research*, *208*(1), 56–62.

Blaser, R. E., & Rosemberg, D. B. (2012). Measures of anxiety in Zebrafish (*Danio rerio*): Dissociation of black/white preference and novel tank test. *PLoS ONE*, *7*(5), e36931.

Blurton Jones, N., & Konner, M. J. (1976). *Kung knowledge of animal behavior* (pp. 325–348). Kalahari hunter-gatherers.

Cashdan, E., & Gaulin, S. J. (2016). Why go there? Evolution of mobility and spatial cognition in women and men. *Human Nature*, *27*(1), 1–15.

Cashdan, E., Marlowe, F. W., Crittenden, A., Porter, C., & Wood, B. M. (2012). Sex differences in spatial cognition among Hadza foragers. *Evolution and Human Behavior*, *33*(4), 274–284.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Champagne, D. L., Hoefnagels, C. C., De Kloet, R. E., & Richardson, M. K. (2010). Translating rodent behavioral repertoire to zebrafish (*Danio rerio*): Relevance for stress research. *Behavioural Brain Research*, *214*(2), 332–342.
Cosmides, L., & Tooby, J. (2000). Evolutionary psychology and the emotions. *Handbook of Emotions*, *2*(2), 91–115.
Davis, H. E., & Cashdan, E. (2019). Spatial cognition, navigation, and mobility among children in a forager-horticulturalist population, the Tsimané of Bolivia. *Cognitive Development*, *52*, 100800.
Deecke, V. B., Slater, P. J., & Ford, J. K. (2002). Selective habituation shapes acoustic predator recognition in harbour seals. *Nature*, *420*(6912), 171–173.
Drai, D., Benjamini, Y., & Golani, I. (2000). Statistical discrimination of natural modes of motion in rat exploratory behavior. *Journal of Neuroscience Methods*, *96*(2), 119–131.
Eilam, D., & Golani, I. (1989). Home base behavior of rats (*Rattus norvegicus*) exploring a novel environment. *Behavioural Brain Research*, *34*(3), 199–211.
Epstein, L. H., Temple, J. L., Roemmich, J. N., & Bouton, M. E. (2009). Habituation as a determinant of human food intake. *Psychological Review*, *116*(2), 384.
Gagnon, K. T., Cashdan, E. A., Stefanucci, J. K., & Creem-Regehr, S. H. (2016). Sex differences in exploration behavior and the relationship to harm avoidance. *Human Nature*, *27*(1), 82–97.
Gagnon, K. T., Thomas, B. J., Munion, A., Creem-Regehr, S. H., Cashdan, E. A., & Stefanucci, J. K. (2018). Not all those who wander are lost: Spatial exploration patterns and their relationship to gender and spatial memory. *Cognition*, *180*, 108–117.
Hawkes, K., Hill, K., & O'Connell, J. F. (1982). Why hunters gather: Optimal foraging and the Ache of eastern Paraguay. *American Ethnologist*, *9*(2), 379–398.
Hill, K., Kaplan, H., Hawkes, K., & Hurtado, A. M. (1987). Foraging decisions among Ache hunter-gatherers: New data and implications for optimal foraging models. *Ethology and Sociobiology*, *8*(1), 1–36.
Huang, P., Kerman, K., Sieving, K. E., & Mary, C. M. S. (2016). Evaluating the novel-environment test for measurement of exploration by bird species. *Journal of Ethology*, *34*(1), 45–51.
Janssen, M. A., & Hill, K. (2014). Benefits of grouping and cooperative hunting among Ache hunter–gatherers: Insights from an agent-based foraging model. *Human Ecology*, *42*(6), 823–835.
Kalueff, A. V., Keisala, T., Minasyan, A., Kuuslahti, M., & Tuohimaa, P. (2006). Temporal stability of novelty exploration in mice exposed to different open field tests. *Behavioural Processes*, *72*(1), 104–112.
New, J., Krasnow, M. M., Truxaw, D., & Gaulin, S. J. (2007). Spatial adaptations for plant foraging: Women excel and calories count. *Proceedings of the Royal Society B: Biological Sciences*, *274*(1626), 2679–2684.
Orians, G. H., & Heerwagen, J. H. (1992). Evolved responses to landscapes. In Barkow, J. H., Cosmides, L., & Tooby, J. (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 555–579). Oxford University Press.
Ross, C. T., & Winterhalder, B. (2018). Evidence for encounter-conditional, area-restricted search in a preliminary study of Colombian blowgun hunters. *PLoS ONE*, *13*(12), e0207633.
Scalise Sugiyama, M. (2004). Predation, narration, and adaptation: "Little Red Riding Hood" revisited. *Interdisciplinary Literary Studies*, *5*(2), 110–129.
Scalise Sugiyama, M. (2008a). Narrative as social mapping. Case study: The trickster genre and the free rider problem. *Ometeca*, *12*, 24–43.
Scalise Sugiyama, M. (2008b). Information is the stuff of narrative. *Style*, *42*(2–3), 254–260.
Scalise Sugiyama, M. (2009). The plot thickens: What children's stories tell us about mindreading.
Scalise Sugiyama, M. (2011). The forager oral tradition and the evolution of prolonged juvenility. *Frontiers in Psychology*, *2*, 133
Scalise Sugiyama, M. (2017a). Distant time: A possible typological literary universal. In Hogan, P. (Ed.), *The literary universals project*. University of Connecticut. http://literary-universals.uconn.edu/2017/01/31/distant-time-a-possible-typological-literary-universal/.
Scalise Sugiyama, M. (2017b). Narrative. In Weekes-Shackelford, V. & Shackelford, T. (Eds.), *Encyclopedia of evolutionary psychological science*. Springer. https://doi.org/10.1007/978-3-319-16999-6_3316-1.
Scalise Sugiyama, M. (2019). The relevance of popularity: Ecological factors at play in story pervasiveness. In Vanderbeke, D., & Cooke, B. (Eds.), *Evolution and popular narrative* (pp. 245–263). Brill Rodopi.
Scalise Sugiyama, M. (2021). The fiction that fiction is fiction. *ASEBL Journal*, *15*, 8–12. https://resources.finalsite.net/images/v1610065663/sfc/pj4pmi0aeaffqpvyasgb/ASEBLJournalvol15January2021.pdf.
Scalise Sugiyama, M., & Sugiyama, L. (2009). A frugal (re) past: Use of oral tradition to buffer foraging risk. *Studies in the Literary Imagination*, *42*(2), 15–41.
Scalise Sugiyama, M. & Sugiyama, L. S., (2011). Once the child is lost he dies': Monster stories vis-à-vis the problem of errant children. In Slingerland, E., & Collard, M. *Creating consilience: Integrating the sciences and the humanities*, 351–371
Schaffer, A., Caicoya, A. L., Colell, M., Holland, R., Ensenyat, C., & Amici, F. (2020). Gaze following in ungulates: Domesticated and non-domesticated species follow the gaze of both humans and conspecifics in an experimental context. *Frontiers in Psychology*, *11*, 3087.
Schloegl, C., Kotrschal, K., & Bugnyar, T. (2007). Gaze following in common ravens, *Corvus corax*: Ontogeny and habituation. *Animal Behaviour*, *74*(4), 769–778.
Seimon, T. A., Seimon, A., Daszak, P., Halloy, S. R., Schloegel, L. M., Aguilar, C. A., … Simmons, J. E. (2007). Upward range extension of Andean anurans and chytridiomycosis to extreme elevations in response to tropical deglaciation. *Global Change Biology*, *13*(1), 288–299.
Shepherd, S. V. (2010). Following gaze: Gaze-following behavior as a window into social cognition. *Frontiers in Integrative Neuroscience*, *4*, 5.
Stewart, A., Cachat, J., Wong, K., Gaikwad, S., Gilder, T., DiLeo, J., … Kalueff, A. V. (2010). Homebase behavior of zebrafish in novelty-based paradigms. *Behavioural processes*, *85*(2), 198–203.
Stewart, A. M., Gaikwad, S., Kyzar, E., & Kalueff, A. V. (2012). Understanding spatiotemporal strategies of adult zebrafish exploration in the open field test. *Brain Research*, *1451*, 44–52.
Sugiyama, L. S. (2015). Physical attractiveness in adaptationist prspective. In D. Buss (Ed.), *The handbook of evolutionary psychology* (pp. 292–343). Wiley.
Sugiyama, M. S., & Sugiyama, L. S. (2011). Once the child is lost he dies': Monster stories vis-a-vis the problem of errant children. In *Creating consilience: Integrating the sciences and the humanities* (pp. 351–371).
Thompson, S. M., Berkowitz, L. E., & Clark, B. J. (2018). Behavioral and neural subsystems of rodent exploration. *Learning and Motivation*, *61*, 3–15.
Tooby, J., & Cosmides, L. (1990). The past explains the present: Emotional adaptations and the structure of ancestral environments. *Ethology and Sociobiology*, *11*(4–5), 375–424.
Tooby, J., & Cosmides, L. (1992). The psychological foundations of culture. In Barkow, J. H., Cosmides, L., & Tooby, J. (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 19–136). Oxford University Press.
Tooby, J., Cosmides, L., Sell, A., Lieberman, D., & Sznycer, D. (2008). Internal regulatory variables and the design of human motivation: A computational and evolutionary approach. *Handbook of Approach and Avoidance Motivation*, *15*, 251.
Trumble, B. C., Gaulin, S. J., Dunbar, M. D., Kaplan, H., & Gurven, M. (2016). No sex or age difference in dead-reckoning ability among Tsimane forager-horticulturalists. *Human Nature*, *27*(1), 51–67.
Vashro, L., & Cashdan, E. (2015). Spatial cognition, mobility, and reproductive success in northwestern Namibia. *Evolution and Human Behavior*, *36*(2), 123–129.
Wiessner, P. W. (2014). Embers of society: Firelight talk among the Ju/'hoansi Bushmen. *Proceedings of the National Academy of Sciences*, *111*(39), 14027–14035.
Wood, B. M., Harris, J. A., Raichlen, D. A., Pontzer, H., Sayre, K., Sancilio, A., … Cashdan, E. (2021). Gendered movement ecology and landscape use in Hadza hunter-gatherers. *Nature Human Behaviour*, *5*(4), 436–446.

Why imaginary worlds? The role of self-exploration within online gaming worlds

Kim Szolin and Mark D. Griffiths

International Gaming Research Unit, Psychology Department, Nottingham Trent University, Nottingham NG1 4FQ, UK
kim.szolin2016@my.ntu.ac.uk;
http://www.ntu.ac.uk/apps/Profiles/51652-1-4/Professor_Mark_Griffiths.aspx
Mark.Griffiths@ntu.ac.uk

doi:10.1017/S0140525X21002077, e302

Abstract

Dubourg and Baumard posited that preferences for exploration are the key to the popularity in imaginary worlds. This commentary argues that other forms of exploration may also account for the success and appeal of specific types of imaginary worlds, namely self-exploration within interactive imaginary worlds such as videogames.

Dubourg and Baumard (D&B) posited that the key reason for the popularity and enduring appeal of imaginary worlds is that they "tap into human's preferences for exploration" (target article,

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

sect. 7.1, para. 1) and do so primarily in terms of the spatial environments of these worlds. However, we would argue that other forms of exploration may also account for the success and appeal of specific types of imaginary worlds, namely self-exploration within interactive imaginary worlds such as videogames.

Videogames provide a unique experience in regard to exploring imaginary worlds. Whereas other forms of fictional media, such as books and films, are able to present an individual with a textual or visual window into an imaginary world, the nature of these formats inevitably means the viewer remains merely a passive observer of these worlds. However, in the case of imaginary worlds in videogames, the individual is not only an observer of the fictional world, but has a virtual presence and may actively engage and explore their gaming world environment.

Beyond exploring the spatial environments of their gaming worlds, individuals may also use videogames to explore facets of themselves that may be difficult or impossible to do in the real world. More specifically, research has demonstrated that videogame players will often design their virtual world avatar to physically resemble a "better" version of themselves in terms of attractiveness, fitness and/or other physical characteristics (Ducheneaut, Wen, Yee, & Wadley, 2009; Messinger et al., 2008). A similar process has also been found to be present in relation to the personality of the videogame player exhibited through the avatar in a game world, with users again frequently adopting a "better" version of their personality in terms of socially desirable traits and behaviours during gameplay (Bessière, Seay, & Kiesler, 2007; Sibilla & Mancini, 2018).

However, the exploration of the self does not always mean a "better" self, but can also encompass a more negative and less socially desirable version of the self. For example, research by Mancini and Sibilla (2017) found that videogame players may use their avatar as a way to explore a "worse" version of their offline actual self, referring to these avatar types as the "negative hero" or "alter-ego." In these instances, players display more negative characteristics through their avatar compared to their offline self, and includes lower emotional stability, agreeableness and extraversion. Nevertheless, functionally this process is the same as the "better" version of the individual's self-avatar, and the virtual environment allows the videogame player to explore a version of themselves that is "worse" than their offline self that would be difficult to enact in the physical world due to societal pressures to avoid exhibiting socially undesirable traits or behaviours. This demonstrates that, whether it be a "better" or "worse" version of the self, online videogame worlds provide environments that allow an individual to experiment with and explore different versions of their self without the constraints and restrictions placed by the physical world.

Furthermore, the role of an avatar in a videogame environment can allow for a more significant and personal exploration of the self, including compensating for self-perceived deficits or personal inadequacies by adopting the desirable personality traits of an entirely different fictional species. For instance, a recent study by Morcos et al. (2021) found that playing as the *Drenei* race (blue anthropomorphised beast creatures from the videogame *World of Warcraft*) was found to be significantly associated with compensatory behaviours. This indicates that individuals who have experienced some form of real-world hardship or self-perceived deficit may identify with and play as this particular race based on the in-game lore which details them as having both a traumatic history and resilient nature. Through personal identification with this race, videogame players may use the virtual environment of the videogame to explore a version of themselves that has the desirable personality traits of this fictional race and compensate for their self-perceived deficits present in the offline world.

Finally, this exploration of the self through an avatar can sometimes be much more pronounced and notable, with some gamers using their avatar as a means of exploring different gender identities through "gender swapping" in-game (Hussain & Griffiths, 2008). In particular, research indicates that some videogame players will use an avatar of the opposite gender in order to experiment with their gender identity in an environment that not only allows for much easier manipulation of visual characteristics than the physical world, but which is also viewed as safer and less threatening than the physical world (Arcelus et al., 2017; Griffiths, Arcelus, & Bouman, 2016). Consequently, individuals may use videogame environments as a precursor to coming out in the physical world, taking advantage of the freedom inherent in this virtual environment to develop and explore a part of themselves that would otherwise be difficult to do in a non-virtual setting (Morgan, O'Donovan, Almeida, Lin, & Perry, 2020). This highlights how the virtual world environments of videogames can be utilised by individuals to not only explore a version of their self that would be physically as well as perhaps socially difficult to accomplish in a non-virtual environment, but also to build and develop this version of the self in a safe and less critical environment before embracing this identity in the real world.

According to D&B, spatial exploration forms an intrinsic part of the enduring appeal of imaginary worlds. However, in the example of interactive imaginary gaming worlds, this allure may extend beyond exploring fictional environments and encompass self-exploration. While the forms of exploration discussed by D&B are likely an important part of the popularity of interactive imaginary worlds such as videogames, the authors did not consider that self-exploration can also be another key factor in the imaginary worlds of videogame playing and that many gamers create avatars to explore facets of their personality that is difficult or even impossible to do in the real world.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Arcelus, J., Jones, B., Richards, C., Jimenez-Murcia, S., Bouman, W.P., & Griffiths, M. D. (2017). Video gaming and gaming addiction in transgender people: An exploratory study. *Journal of Behavioral Addictions*, *6*(1), 21–29. https://doi.org/10.1556/2006.6.2017.002.

Bessière, K., Seay, A. F., & Kiesler, S. (2007). The ideal elf: Identity exploration in World of Warcraft. *Cyberpsychology & Behavior*, *10*(4), 530–535. https://doi.org/10.1089/cpb.2007.9994.

Ducheneaut, N., Wen, M. H., Yee, N., & Wadley, G. (2009). Body and mind: A study of avatar personalization in three virtual worlds. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 1151–1160). ACM Press.

Griffiths, M. D., Arcelus, J., Bouman, W. P. (2016). Video gaming and gender dysphoria: Some case study evidence. *34*(2), 59–66. Retrieved from https://raco.cat/index.php/Aloma/article/view/315262 [Consulta: 28-08-2021].

Hussain, Z., & Griffiths, M. D. (2008). Gender swapping and socializing in cyberspace: An exploratory study. *CyberPsychology & Behavior*, *11*(1), 47–53. https://doi.org/10.1089/cpb.2007.0020.

Mancini, T., & Sibilla, F. (2017). Offline personality and avatar customisation. Discrepancy profiles and avatar identification in a sample of MMORPG players. *Computers in Human Behavior*, *69*, 275–283. https://doi.org/10.1016/j.chb.2016.12.031.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Messinger, P. R., Ge, X., Stroulia, E., Lyons, K., Smirnov, K., & Bone, M. (2008). On the relationship between my avatar and myself. *Journal for Virtual Worlds Research*, *1*(2), 1–17. https://doi.org/10.4101/jvwr.v1i2.352.

Morcos, M., Stavropoulos, V., Rennie, J. J., Clark, M., & Pontes, H. M. (2021). Internet gaming disorder: Compensating as a Draenei in World of Warcraft. *International Journal of Mental Health and Addiction*, *19*, 669–685. https://doi.org/10.1007/s11469-019-00098-x.

Morgan, H., O'Donovan, A., Almeida, R., Lin, A., & Perry, Y. (2020). The role of the avatar in gaming for trans and gender diverse young people. *International Journal of Environmental Research and Public Health*, *17*(22), 8617. https://doi.org/10.3390/ijerph17228617.

Sibilla, F., & Mancini, T. (2018). I am (not) my avatar: A review of the user-avatar relationships in massively multiplayer online worlds. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, *12*(3), 4. https://doi.org/10.5817/CP2018-3-4.

Imaginative processes in children are not particularly imaginative

Deena Skolnick Weisberg[a] and David M. Sobel[b]

[a]Department of Psychological and Brain Sciences, Villanova University, Tolentine Hall, Villanova, PA 19085, USA and [b]Department of Cognitive, Linguistic, and Psychological Sciences, Brown University, Providence, RI 02912, USA
deena.weisberg@villanova.edu; starlabkids.org
dave_sobel@brown.edu; causalityandmindlab.wordpress.com

doi:10.1017/S0140525X21002089, e303

Abstract

The authors argue that children prefer fictions with imaginary worlds. But evidence from the developmental literature challenges this claim. Children's choices of stories and story events show that they often prefer realism. Further, work on the imagination's relation to counterfactual reasoning suggests that an attraction to unrealistic fiction would undermine the imagination's role in helping children understand reality.

The authors propose an interesting answer to the important question of why people imagine. From our perspective as developmental psychologists, however, there are several aspects of their arguments that do not fit with what we know about how children imagine. The failure of the authors to consider the ways that children engage in and understand imagination makes us question the generalizability of their arguments. To illustrate this concern, here we will focus whether children are more attracted to imaginary worlds than realistic ones.

Based on their arguments linking imagination to exploration, the authors predict that children will be especially attracted to fantastical fiction. As a primary piece of evidence, they note that many fictions aimed at children are fantastical (see target article, sect. 5.2, but also *Harry Potter*, *The Little Prince*, and *The Adventures of Pinocchio*, just to name several of the bestselling children's books of all time). This argument, however, ignores the fact that these fictional worlds were created by adults and presented to children by adults. These stories thus potentially reflect adults' assumptions about children's preferences, rather than necessarily capturing children's preferences.

Indeed, there is much evidence to suggest that children may be more reality-prone than fantasy-prone. For example, Weisberg, Sobel, Goodstein, and Bloom (2013) showed preschool-aged children a story that either had only realistic elements or that included fantastical elements (e.g., a character walked to the store or teleported to the store). At various points in the story, children were asked to choose which of two events should come next: a realistic one or a fantastical one. Regardless of which story they had heard, children were more likely to choose the realistic event. Similarly, Sobel and Weisberg (2014) asked preschool-aged children to create their own stories by choosing between pairs of events, one of which was realistic (e.g., a character walked through a door) and the other of which was fantastical (e.g., a character walked through a wall). While 3-year-olds responded randomly in their story construction, older children were coherent in the fictional worlds they created: 80% of the 4-year-olds in this sample constructed stories that were made up of mostly (or exclusively) realistic events.

Other studies have found that, when preschoolers are asked to choose which stories or which events they prefer, they tend to choose more realistic than fantastical stories or events (Barnes, Bernstein, & Bloom, 2015; Weisberg et al., 2013). Children also report that they prefer engaging in real activities rather than in pretend activities (Taggart, Heise, & Lillard, 2017; Taggart, Becker, Reuen, Al Kallas, & Lilliard, 2020). This work generally challenges the authors' claims that children are attracted to fictions with imaginary worlds, weakening their argument about the importance of exploration in the preference for such fictions.

Additionally, and perhaps more importantly, the argument that people (especially children) prefer to explore fictions with imaginary worlds is in direct conflict with empirical work on other cognitive capacities that rely on imagination. There is a large body of evidence demonstrating that there are important links between imagination and the ability to reason counterfactually and hypothetically (e.g., Buchsbaum, Bridgers, Weisberg, & Gopnik, 2012; Gopnik & Walker, 2013; Nyhout & Ganea, 2019; Schacter, 2012; Weisberg & Gopnik, 2013). This work posits that part of the utility of our imaginative abilities is that they allow us to make sense of reality. Imagination does allow us to explore fantastical fictional worlds, as the authors argue, but imagination also allows us to regret, to imagine alternatives to past events, and to consider different hypotheses for how the world might work. Because of this, many – perhaps even a majority – of our imaginative activities involve mundane situations, as we consider what we should have done in a past situation or rehearse what we might do in the future.

In order to engage in such reasoning, both adults and children must appropriately constrain the worlds that they imagine so that these possible worlds reflect how reality could work (e.g., Seelau, Seelau, Wells, & Windschitl, 1995; see also Weisberg, 2020). The kind of overriding preference for exploring imaginative worlds that the authors argue for would undermine these crucial functions. The authors do not consider these vital aspects of how the imagination works, making some of their arguments less credible.

In general, we encourage the authors to integrate their arguments more with the developmental literature, to ensure that their claims about the role of exploration in imagination align with what we know about how children imagine. In doing so, perhaps a middle ground can be found in work on fantasy orientation, which measures individual children's level of attraction to imaginative scenarios in media or in their play (e.g., Bunce & Woolley, 2021; Pierucci, O'Brien, McInnis, Gilpin, & Barber, 2013; Thibodeau, Gilpin, Brown, & Meyer, 2016). For example, work on children's creation of imaginary companions or paracosms finds that a stable minority of children (about 20%) tend

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

to do so (Taylor, 1999; Taylor, Mottweiler, Aguiar, Naylor, & Levernier, 2020). Similarly, in the study on story construction described above (Sobel & Weisberg, 2014), while 80% of the 4-year-olds created their stories out of realistic events, the other 20% chose mostly fantastical events. That is, some children – but certainly not all – might be highly engaged by fantastical fiction. Considering why these individual differences occur and how they relate to children's other capacities and preferences could be a fruitful way for the authors to begin to incorporate more of a developmental perspective into their theory.

Funding. The authors did not receive any funding to support this commentary.

Conflict of interest. None.

References

Barnes, J. L., Bernstein, E., & Bloom, P. (2015). Fact or fiction? Children's preferences for real versus make-believe stories. *Imagination, Cognition and Personality*, *34*(3), 243–258. https://doi.org/10.1177/0276236614568632

Buchsbaum, D., Bridgers, S., Weisberg, D. S., & Gopnik, A. (2012). The power of possibility: Causal learning, counterfactual reasoning, and pretend play. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1599), 2202–2212. https://doi.org/10.1098/rstb.2012.0122

Bunce, L., & Woolley, J. D. (2021). Fantasy orientation and creativity in childhood: A closer look. *Cognitive Development*, *57*, 100979. https://doi.org/10.1016/j.cogdev.2020.100979

Gopnik, A., & Walker, C. M. (2013). Considering counterfactuals: The relationship between causal learning and pretend play. *American Journal of Play*, *6*(1), 15–28.

Nyhout, A., & Ganea, P. A. (2019). The development of the counterfactual imagination. *Child Development Perspectives*, *13*(4), 254–259. https://doi.org/10.1111/cdep.12348

Pierucci, J. M., O'Brien, C. T., McInnis, M. A., Gilpin, A. T., & Barber, A. B. (2013). Fantasy orientation constructs and related executive function development in preschool: Developmental benefits to executive functions by being a fantasy-oriented child. *International Journal of Behavioral Development*, *38*(1), 62–69. https://doi.org/10.1177/0165025413508512

Schacter, D. L. (2012). Adaptive constructive processes and the future of memory. *American Psychologist*, *67*(8), 603–613. https://doi.org/10.1037/a0029869

Seelau, E. P., Seelau, S. M., Wells, G. L., & Windschitl, P. D. (1995). Counterfactual constraints. In N. J. Roese & J. M. Olson (Eds.), *What might have been: The social psychology of counterfactual thinking* (pp. 57–80). Psychology Press.

Sobel, D. M., & Weisberg, D. S. (2014). Tell me a story: How children's developing domain knowledge affects their story construction. *Journal of Cognition and Development*, *15*(3), 465–478. https://doi.org/10.1080/15248372.2012.736111

Taggart, J., Becker, I., Rauen, J., Al Kallas, H., & Lillard, A. S. (2020). What shall we do: Pretend or real? Preschoolers' choices and parents' perceptions. *Journal of Cognition and Development*, *21*(2), 261–281. https://doi.org/10.1080/15248372.2019.1709469

Taggart, J., Heise, M. J., & Lillard, A. S. (2017). The real thing: Preschoolers prefer actual activities to pretend ones. *Developmental Science*, *21*(3), e12582. https://doi.org/10.1111/desc.12582

Taylor, M. (1999). *Imaginary companions and the children who create them*. Oxford University Press.

Taylor, M., Mottweiler, C. M., Aguiar, N. R., Naylor, E. R., & Levernier, J. G. (2020). Paracosms: The imaginary worlds of middle childhood. *Child Development*, *91*(1), e164–e178. https://doi.org/10.1111/cdev.13162

Thibodeau, R. B., Gilpin, A. T., Brown, M. M., & Meyer, B. A. (2016). The effects of fantastical pretend-play on the development of executive functions: An intervention study. *Journal of Experimental Child Psychology*, *145*, 120–138. https://doi.org/10.1016/j.jecp.2016.01.001

Weisberg, D. S. (2020). Is imagination constrained enough for science? In A. Levy & P. Godfrey-Smith (Eds.), *The scientific imagination: Philosophical and psychological perspectives* (pp. 250–261). Oxford University Press.

Weisberg, D. S., & Gopnik, A. (2013). Pretense, counterfactuals, and Bayesian causal models: Why what is not real really matters. *Cognitive Science*, *37*(7), 1368–1381. https://doi.org/10.1111/cogs.12069

Weisberg, D. S., Sobel, D. M., Goodstein, J., & Bloom, P. (2013). Young children are reality-prone when thinking about stories. *Journal of Cognition and Culture*, *13*(3–4), 383–407. https://doi.org/10.1163/15685373-12342100

The deep history of imaginary worlds

Polly Wiessner

School of Human Evolution and Social Change, Arizona State University, Tempe, AZ, 85287, USA and Department of Anthropology, University of Utah, Salt Lake City, UT, 84112, USA
wiessner@soft-link.com; https://shesc.asu.edu/people/pauline-wiessner

doi:10.1017/S0140525X21002132, e304

Abstract

If recent exploratory traditions tap into evolved psychological dispositions to explore, wouldn't humans be expected to have drawn on such dispositions long before the written word? Trickster oral traditions fill this role in all levels of society, affluence, and on all continents, inverting the boundaries of social worlds and those between humans and animals, fostering cultural innovation.

The central hypothesis of Dubourg and Baumard is that imaginary worlds, which are such popular and lucrative cultural products in industrial societies today, tap into psychological dispositions which evolved in humans and non-human animals alike for the exploration of new environments. The authors trace the construction of imaginary worlds to ancient fictive literature and relate their current flourish to openness or tolerance, the curiosity of younger age groups, and secure, affluent ecologies. But are such cultural products only those of the affluent, secure, and young or have humans drawn on exploratory dispositions since the dawn of humanity to venture into imaginary worlds?

Anthropological studies of oral traditions in small-scale societies indicate that fiction is by no means new. Myths account for the origins of humans, formation of the landscape, and of social groups worldwide (Vansina, 1985). Epics and legends have historical dimensions entwined with fiction. However, among the broad repertoire of oral traditions, the most salient explorations of imaginary worlds are trickster traditions which have engaged audiences on all continents and in societies of different degrees of affluence and complexity long before the written word. Renowned tricksters include Loki the Norse God of chaos, Anansi the Ghanaian spider trickster, the Chinese Monkey King, the Greek Hermes, the Indonesian Mouse Deer and the Coyote and Raven from North America (Hyde, 1997).

Tricksters are sly, outrageous characters who live in largely imaginary worlds, defy the social and moral order, release humans from social constraints, and alter perceptions. Tricksters explore novel relations as well as alternatives to the present system, allowing people to reevaluate norms and contemplate change. They live on the periphery of the existing world, change in form from humans to objects to animals and venture on imaginary journeys. They embody human habits and character and are endowed with mental nimbleness to satisfy their wants.

Trickster traditions have many episodes or "seasons," though these are not organized sequentially. For example, tales of the Coyote's wild adventures are told from the Arctic to Mexico. As part-human part-animal, he combines characteristics of sacredness and sinfulness, grand gestures and pettiness, strength and weakness, joy and misery, heroism and cowardliness (Hyde, 1997). Good and evil are wrapped up in one character unlike

traditions of today that pit good against evil. Above all, he, like many tricksters, is greedy and gets what he wants, often food and women. Among Kalahari Khoisan, the trickster God //Gauwa may appear as a game animal, bird, insect, plant, rock, whirlwind, or cooking pot to obtain the most choice pieces of meat. But he is also the creator of beings, rules, and categories, though he transforms, distorts, or inverts what he has created or decreed (Guenther, 1999, p. 101.) As Biesele (1995) has noted for the Kalahari Ju/'hoansi, twists of plot do not violate central themes but rather explore their ramifications and how many intellectual changes can be rung on the same theme and plot.

What environments are explored in trickster traditions? Though human nature is a theme that runs through traditions of all societies, stories from small-scale, subsistence-based societies delve largely into the boundaries of social worlds and those between humans and animals. This is not surprising as in such societies people are secured by mutually supportive social ties and direct interactions with the natural environment (Wiessner, 2014). Norms governing interpersonal relations and the cultural order are designed to reduce the transaction costs of social and economic change. As such they are constantly pushed to the limits as individuals compete and seek new opportunities. Tolerance for variation in relationships and practices is considerable and widely discussed, just as the slippery exploits of tricksters draw fascination and laughter rather than disapproval.

Traditions involving imaginary worlds have proliferated in industrial societies. Nonetheless, whether in firelit sessions in the Kalahari where Bushmen of all ages roll in laughter as Tricksters invert the social order, or in the imaginary stories of the Tlingit of the NW pacific that extend for days in the winter months, the tendency to tap into dispositions to explore imaginary worlds is a near cultural universal. It appears to have deep roots in human societies and provide the variation on which cultural innovation and adaptation draw.

Funding. None.

Conflict of interest. None.

References

Biesele, M. (1995). "Different people just have different minds": A personal attempt to understand Ju/'hoan storytelling aesthetics. *Current Writing: Text and Reception in Southern Africa*, *7*(2), 1–17.

Guenther, M. G. (1999). *Tricksters and trancers: Bushman religion and society*. Indiana University Press.

Hyde, L. (1997). *Trickster makes this world: Mischief, myth, and art*. Macmillan.

Vansina, J. M. (1985). *Oral tradition as history*. University of Wisconsin Press.

Wiessner, P. W. (2014). Embers of society: Firelight talk among the Ju/'hoansi Bushmen. *Proceedings of the National Academy of Sciences*, *111*(39), 14027–14035.

Not just a hijack: Imaginary worlds can enhance individual and group-level fitness

Danica Wilbanks[a], Jordan W. Moon[b], Brent Stewart[c], Kurt Gray[a] and Michael E. W. Varnum[b]

[a]Department of Psychology and Neuroscience, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3270, USA; [b]Department of Psychology, Arizona State University, Tempe, AZ 85287-1104, USA and [c]University of British Columbia, Vancouver, BC V6T 1Z4, Canada
danicaw@email.unc.edu
jwmoon1@asu.edu; https://sites.google.com/view/jordanmoon/home
brent.stewart@psych.ubc.ca
kurtgray@unc.edu; https://www.kurtjgray.com/
mvarnum@asu.edu; https://sites.google.com/site/mewvarnum

doi:10.1017/S0140525X21002144, e305

Abstract

Why has fiction been so successful over time? We make the case that fiction may have properties that enhance both individual and group-level fitness by (a) allowing risk-free simulation of important scenarios, (b) effectively transmitting solutions to common problems, and (c) enhancing group cohesion through shared consumption of fictive worlds.

Soldiers often fight real battles against enemies, but they just as often fight pretend – or fictive – battles against imagined enemies. Generals imagine new scenarios and soldiers both think through them and act through them. One might be tempted to argue that these mere "war games" are a distraction from the real business of war – hijacking the minds of soldiers for silly diversions. But these scenarios have another name that reveals their true purpose: "readiness exercises." These exercises ready soldiers for the real business of war. They allow soldiers to practice their skills, be exposed to new scenarios, try new strategies in a (relatively) safe space, and bond and coordinate with their comrades. In war, fictive scenarios are not a distraction but crucial preparation for an uncertain world.

Not everyone fights battles, but each of us lives in an uncertain and sometimes dangerous world, where threats abound and people must constantly work to be prepared for the future. And yet people around the world and through history spend countless hours consuming fiction? Why? Perhaps people are easily distracted and their systems are easily hijacked. Or perhaps it helps to think of fiction from a different perspective – not as mental parasites, but as "readiness exercises" for life.

We certainly agree with Dubourg and Baumard (D&B) that imaginary worlds serve many purposes. Indeed, the examples cited in their review include conveying important lessons, spreading culturally valued information, and allowing the simulation of new scenarios. They argue, however, that these fictive worlds (and their success) can best be understood as effectively a "hijack" of an evolved motivational system to explore one's environment. Our take on the persistence and success of these imaginary worlds is somewhat different, namely we argue that fiction may have been so successful over time primarily because it may enhance fitness at both the individual and the group-level.

First, fiction extends phenotypic flexibility beyond the natural environment by preparing people for a wider range of situations than they might encounter in their normal environments. Fiction lets people explore new scenarios with minimal risk. Just as readiness exercises help soldiers prepare for battle, fiction enables people to explore a wide range of experiences in a risk-free "life simulator." For instance, fans of horror or "prepper" films may actually be better off once emergency strikes (Scrivner, Johnson, Kjeldgaard-Christiansen, & Clasen, 2021), and readers of Victorian novels might be better off when cooperative needs arise (Johnson, Carroll, Gottschall, & Kruger, 2011). The stories parents tell to children might also transmit advice

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

in a way that is memorable for the child (Mar & Oatley, 2008), enabling humans during an especially vulnerable point in their development to learn about various dangers in a low-risk fashion.

It may seem odd to argue that fiction helps to prepare us for the world, because the scenarios depicted are often more extreme than those encountered in everyday life. For example, fiction includes much more mortality than real life (Morin, Acerbi, & Sobchuk, 2019). But this is actually the benefit of fiction – if fiction helps people prepare for high-stakes situations, one might expect overrepresentation of risky or dangerous scenarios. Thus by enabling individuals to learn about and prepare for events beyond those previously or frequently encountered, fiction may increase individuals' ability to successfully respond to future threats and opportunities in their environments.

Fiction is also packed with problem–solution scenarios. These scenarios give opportunities for people to practice challenges they may not otherwise experience in a relatively short time (Boyd, 2018). In the time it takes to read a book or watch a movie, the viewer has simulated more scenarios than they could have experienced in real life. This leads to our second point: fiction enables more efficient transmission of information, skills, and values than might be possible with other means. As D&B note, fiction grabs our attention by focusing on the parts of life that we find most interesting while filtering out monotonous noise. Not only does this quality contribute to fiction's success, it also allows fiction to convey more relevant information than one could normally acquire and allows for the rapid spread of this shared information among group members. For example, people understand and recall stories better than expository texts (Mar, Li, Nguyen, & Ta, 2021), and social information better than asocial information (Mesoudi, Whiten, & Dunbar, 2006). Further, stories often utilize repetition and social learning, both of which help people learn new skills (Jiménez & Mesoudi, 2019; Silveira, 2021). We suggest that by rapidly spreading fitness-relevant knowledge with high fidelity, the consumption of fiction should yield fitness benefits to both individuals and groups.

Finally, shared consumption of rich fictive worlds can unify groups and create shared realities and goals. This may enhance group cohesion and provide advantages in competition with other groups whose fictive worlds are less rich or absent. Fiction has been shown to increase prosociality (Johnson, 2012; Johnson, Cushman, Borden, & McCune, 2013; Smith et al., 2017). For example, a recent study of the Agta, a Filipino hunter-gatherer population, found that having good storytellers was associated with increased cooperation within groups (Smith et al., 2017). Fiction is especially apt at strengthening cultural norms because people emulate others they perceive as prestigious (Jiménez & Mesoudi, 2019), and fans often admire fictional characters. Thus fiction may enhance group fitness through strengthening cooperation and a sense of shared identity within the group.

If we consider fiction as adaptive at multiple levels of selection, we may derive several novel predictions. (1) All other things being equal, individuals who consume more fiction might be better prepared to respond adaptively to rare events with a high potential threat to survival. (2) All other things being equal, people may find potential interaction partners or mates who consume more fiction more appealing. (3) To the extent that fictive worlds enhance cooperation within groups, we would predict that richer fictive worlds may have proceeded increases in group size historically, and that cooperation-enhancing fiction might be especially common where societies face large-scale coordination challenges. (4) Societies where consumption of fiction is more common might have more unified responses to external threats.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Boyd, B. (2018). The evolution of stories: From mimesis to language, from fact to fiction. *Wiley Interdisciplinary Reviews: Cognitive Science*, *9*(1), e1444.

Jiménez, Á. V., & Mesoudi, A. (2019). Prestige-biased social learning: Current evidence and outstanding questions. *Palgrave Communications*, *5*(1), 1–12.

Johnson, D. R. (2012). Transportation into a story increases empathy, prosocial behavior, and perceptual bias toward fearful expressions. *Personality and Individual Differences*, *52*(2), 150–155.

Johnson, D. R. (2013). Transportation into literary fiction reduces prejudice against and increases empathy for Arab-Muslims. *Scientific Study of Literature*, *3*(1), 77–92.

Johnson, D. R., Cushman, G. K., Borden, L. A., & McCune, M. S. (2013). Potentiating empathic growth: Generating imagery while reading fiction increases empathy and prosocial behavior. *Psychology of Aesthetics, Creativity, and the Arts*, *7*(3), 306.

Johnson, J. A., Carroll, J., Gottschall, J., & Kruger, D. (2011). Portrayal of personality in Victorian novels reflects modern research findings but amplifies the significance of agreeableness. *Journal of Research in Personality*, *45*, 50–58.

Mar, R. A., Li, J., Nguyen, A. T., & Ta, C. P. (2021). Memory and comprehension of narrative versus expository texts: A meta-analysis. *Psychonomic Bulletin & Review*, *28*(3), 732–749.

Mar, R. A., & Oatley, K. (2008). The function of fiction is the abstraction and simulation of social experience. *Perspectives on Psychological Science*, *3*(3), 173–192.

Mesoudi, A., Whiten, A., & Dunbar, R. (2006). A bias for social information in human cultural transmission. *British Journal of Psychology*, *97*(3), 405–423.

Morin, O., Acerbi, A., & Sobchuk, O. (2019). Why people die in novels: Testing the ordeal simulation hypothesis. *Palgrave Communications*, *5*(1), 1–10.

Scrivner, C, Johnson, J. A., Kjeldgaard-Christiansen, J, & Clasen, M. (2021). Pandemic practice: Horror fans and morbidly curious individuals are more psychologically resilient during the COVID-19 pandemic. *Personality and Individual Differences*, *168*, 110397.

Silveira Jr, A. S. (2021). The power of repetition. In *Building and managing high-performance distributed teams* (pp. 155–167). Apress.

Smith, D., Schlaepfer, P., Major, K., Dyble, M., Page, A. E., Thompson, J., … Migliano, A. B. (2017). Cooperation and the evolution of hunter-gatherer storytelling. *Nature Communications*, *8*(1), 1–9.

Determining the markers of a preference for imaginary worlds fiction calls for comparisons across kinds of fiction readers and forms of exploration

Ellen Winner[a,b]

[a]Department of Psychology and Neuroscience, Boston College, McGuinn Hall, Chestnut Hill, MA 02467, USA and [b]Harvard Graduate School of Education, Project Zero, Longfellow Hall, Cambridge, MA 02138, USA
winner@bc.edu; ellenwinner.com

doi:10.1017/S0140525X21002065, e306

Abstract

The authors do not compare readers who prefer imaginary world fiction to readers with other reading preferences, failing to rule out the hypothesis that their findings apply to all readers.

The authors also do not test their hypotheses against plausible alternative ones, several of which are suggested here.

The question underlying this article is whether imaginary world fiction (e.g., a genre of fiction involving a fictional world as well as fantasy, good heroes, evil antiheroes, and magic) has co-opted our presumed evolved intrinsic motivation for exploration of unfamiliar environments. To test this hypothesis, the authors examine whether specific characteristics said to be related to our exploratory drive predict individual variability in preference for imaginary world fiction.

The search for predictors of individual differences in attraction to imaginary worlds fiction needs to be addressed in the context of several broader questions: What differentiates readers from non-readers, fiction from non-fiction readers, and readers of all kinds of fiction from readers who specialize in a particular genre, topic, or style? And for those who specialize, we need at the very least to differentiate readers who prefer imaginary world fiction (e.g., Tolkien) from those who prefer fiction set in the real world (e.g., Balzac). Of course, real-world fiction is not of a piece: Balzac is far more remote than Toni Morrison, both of which are far more "literary" than best-selling author Jacqueline Susann.

Dubourg and Baumard (D&B) test a number of provocative hypotheses about the characteristics of people who consume imaginary world fiction by comparing the characteristics of such individuals to the general population. That the authors do not examine what distinguishes these individuals from those who prefer other kinds of fiction, non-fiction, or who prefer not to read at all, limits the conclusions we can draw. Many characteristics distinguish individuals who like to read from the general population. Reading is associated with education which is associated with socioeconomic status, just to name two obvious characteristics. To find out what distinguishes those drawn to that slice of literature in which events take place in an imaginary world, we need to pit readers of this genre against readers of other kinds of genres. The authors do cite one study (Purhonen et al., 2009) comparing readers of different genres, using that study to support the claim that age is negatively correlated with preference for imaginary world literature. Actually, however, the Purhonen et al. study simply shows that with age, people are less interested in a broad category of fiction that includes science fiction along with thrillers, whodunits, and horror (most of which are not set in an imaginary world).

D&B test whether characteristics related to a drive for spatial exploration characterize readers of imaginary world fiction: age, affluence, openness to experience (and its correlate, academic achievement). Why not a more direct test, examining the reading preferences of those who like actual spatial exploration (hikers, climbers, undersea divers)? After all, the authors state that "humans find imaginary worlds very attractive for the same reasons, and under the same circumstances, as they are lured by unfamiliar environments in real life." Would it be a problem for the theory if people who like to explore novel environments are infrequent fiction readers, or choose to relax by reading whodunnits?

Novel hypotheses should be tested against plausible alternative ones. Here are a few, framed in terms of a contrast between those who prefer imaginary world fiction versus those who prefer other kinds of fiction.

Examine preference for spatial versus psychological exploration. All genres of fiction invite exploration of one sort or another. While imaginary worlds fiction takes readers into a novel environment to be explored, real-world fiction invites readers into the minds of its characters. A greater interest in psychological than spatial issues may be associated with a preference for real-world fiction, while a greater interest in spatial than psychological issues may be associated with a preference for imaginary world fiction. And of course, evolving to read other peoples' minds is as important for survival as is evolving to explore unfamiliar space.

Examine inclination to see world in black and white terms. A preference for imaginary world fiction may be associated with a tendency to see the world in terms of good and evil (a theme which is common in imaginary worlds fiction, e.g., *Lord of the Rings*, *Harry Potter*). In contrast, a preference for real-world fiction may be associated with disinclination to see the world in such black and white terms, and with greater tolerance of moral ambiguity.

Examine sense of agency. A preference for imaginary over real-world fiction may be associated with a sense of lack of agency, for which individuals compensate by identifying with heroic characters possessing magical powers. This is the explanation that psychoanalyst Bettelheim (1976) proposed for children's enduring love of fairy tales, a form of imaginary world fiction in which seemingly helpless children win out over seemingly all powerful evil adults.

Examine education in the humanities versus sciences and mathematics. A preference for imaginary world fiction versus literary fiction might be related to educational background. I would wager that those of any age and affluence level who prefer literary fiction (e.g., Balzac) to imaginary world fiction (e.g., Tolkien) are likely to have had a humanities (rather than a science) education. Their counterparts who prefer Tolkien to Balzac are likely to have had an education focused on science and/or mathematics. An education in the humanities would probably shape individuals to like what we call "literary fiction," which is primarily based in real-world settings, and to dislike imaginary worlds fiction as not serious literature. As anecdotal evidence, I note that the renowned American literary critic, Wilson (1956), did not think that Tolkien was a great writer, referring to his work as "juvenile trash."

In short, there are a variety of possible distinguishing markers of individuals who like fictions about fictional worlds beside the overly general ones presented here argued to be related to our evolved need for spatial exploration.

D&B have posed an interesting question. I would not approach it in the same way, but they have opened up a new area of psychological research, one we should explore broadly, pitting multiple groups as well as alternative hypotheses against one another.

Funding. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of interest. None.

References

Bettelheim, B. (1976). *The uses of enchantment: The meaning and importance of fairy tales*. Knopf.

Purhonen, S., Gronow, J., & Rahkonen, K. (2009). Social differentiation of musical and literary taste patterns in Finland. *Research on Finnish Society*, *2*, 39–49.

Wilson, E. (1956). Oo, those awful orcs! *The Nation*, April 14.

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

Influences on the development of imaginary worlds

Mark J. P. Wolf

Communication Department, Concordia University Wisconsin, Mequon, WI 53097, USA
mark.wolf@cuw.edu

doi:10.1017/S0140525X21002090, e307

Abstract

Dubourg and Baumard's paper takes a different, and fruitful, approach to the study of imaginary worlds than what is usually found in Media Studies, but omits certain circumstances and influences that shaped their history; this article argues that psychological or behavioral factors are not enough to explain the growth of imaginary worlds, even as they may be important influences.

The target article by Dubourg and Baumard takes a different approach to the study of imaginary worlds than what is usually found in Media Studies, and one which I think will yield some interesting fruit, particularly in the area of exploratory preferences and the idea of economic and ecological conditions which may encourage the production of imaginary worlds. At the same time, there are some assertations in the article to which I would have to take exception, where either the history of imaginary worlds does not correspond to their theory, or where other important influences have been omitted.

First, there is the authors' suggestion that "For a long time, people's exploratory preferences were too weak to give rise to the production of imaginary worlds in fictions." Hundreds of imaginary worlds were produced prior to 1900, including some rather detailed and elaborate ones (like More's *Utopia* [1516], Defoe's *Crusoe's Island* [1719], Paltock's *Sass Doorpt Swangeanti* [1750], Defontenay's *Starian system* [1854], and Abbott's *Flatland* [1884]), so it is incorrect to suggest that human beings lacked the cognitive abilities to create elaborate and inventive imaginary worlds of substantial size and with considerable amounts of world data; not only were the above book-length and quite detailed, but some included ancillary materials as well (e.g., More's had a map and a quatrain in the Utopian language, and Paltock's book includes its own glossary with over 100 entries). Some of these worlds were also culturally successful as well, as the influence of works like More's *Utopia*, Defoe's *Robinson Crusoe*, and Dante's *Inferno* demonstrate, since each of them inspired a deluge of imitators.

While I do not disagree with the authors' suggestion that imaginary worlds co-opt our evolved preferences for exploration, it is too much to claim that "This hypothesis can therefore explain the way imaginary worlds evolved culturally, their shape and content" (abstract), since such a claim leaves out other important circumstances and influences that shaped them. One such influence that is not discussed here is the appearance of mass media venues around the turn of the twentieth century. It was the rise of mass media, particularly audiovisual media, that opened up possibilities for imaginary worlds beyond verbal descriptions, maps, and other drawings, encouraging more production of worlds and encouraging some of them to become transmedial worlds. While economic development certainly had some influence on the growth of worlds, it is too broad of a factor, and one which needs to be more materially connected to the production of worlds; for example, one could explore the connection between economic development and the growth of mass media, coupled with an increasing amount of leisure time (due to industrialization and mechanization), that also allowed for more consumption of imaginary worlds. Also, interest in imagined places grew as more of the physical world was explored, losing some of its status as the unknown, and the growing numbers of mediated accounts of real-world places produced an experience closer to that of imaginary worlds, which of course can only be experienced through media.

There is also the suggestion that "too much world data could be bewildering, frustrating or too complex, exactly like the attraction to novelty" (target article, sect. 6.3, para. 1); while this may be true for some people who are not interested in imaginary worlds, there are also very many who enjoy the high levels of detail and large amounts of world data; I have written elsewhere (Wolf, 2013, 2017a, 2017b) about the importance of saturation and overflow, that is, having more world data than the audience member can hold in his or her mind at one time; worlds which are too easily mastered may seem simple, unchallenging, and less interesting by comparison, and soon cease to ignite speculation in the mind of the audience. Also, while I can understand why the authors would refer to imaginary world information as "useless," I would argue that this is not true, since imaginary world knowledge of popular worlds becomes a kind of cultural capital within the fandoms surrounding those worlds, even to level of scholarship about those worlds (with all the scholarship about Tolkien's work providing the best example). Thus, more work in the connection between an imaginary world and the real-world context in which it occurs should be done to explore such connections and effects.

The authors' work on exploratory preferences, and differences in the interest in imaginary worlds due to age, affluence, social stability, and economic background is good, and I suspect a book-length project would be needed to fully explore these areas in a satisfactory way. My comments here may indicate some adjustments and omissions, but their overall work is sound and interesting to consider.

Finally, I can heartily agree with the authors' closing assertion that "we need to be able to quantify the size of imaginary worlds, that is, the amount of background information associated with a particular world." This is something that I have discussed elsewhere (Wolf, 2020), where I examine different criteria for measurement and the problems with them, concluding that a world quantification scheme remains one of the great unsolved problems in Subcreation Studies.

Funding. None.

Conflict of interest. None.

References

Wolf, M. J. P. (2013). *Building imaginary worlds: The theory and history of subcreation*. Routledge.

Wolf, M. J. P. (2017a). Beyond immersion: Absorption, saturation, and overflow in the experiencing of imaginary worlds. In M. Boni (Ed.), *World building: Transmedia, fans, industries* (pp. 204–214). Amsterdam University Press and University of Chicago Press.

Wolf, M. J. P. (2017b). The importance of overflow and chunking in world-building and the experiencing of worlds. In *Revisiting imaginary worlds: A subcreation studies anthology* (pp. 264–275). Routledge.
Wolf, M. J. P. (2020). Appendix: On measuring and comparing imaginary worlds. In *Exploring imaginary worlds: Essays on media, structure, and subcreation* (pp. 225–232). Routledge.

Imagining our moral values in the present and future

Jordan Wylie[a], Alix Alto[a] and Ana Gantman[a,b]

[a]Basic and Applied Psychology, The Graduate Center, City University of New York, New York, NY 10016, USA and [b]Department of Psychology, Brooklyn College, Brooklyn, NY 11215, USA
jwylie@gradcenter.cuny.edu; jordancwylie.com
agetreu@gradcenter.cuny.edu; alixalto.com
ana.gantman@brooklyn.cuny.edu

doi:10.1017/S0140525X21002156, e308

Abstract

Imaginary worlds allow us to safely develop, crystallize, and criticize our moral values – at times even serving as catalysts for change in the real world. Fans of imaginary worlds sometimes form groups to advocate for social change in the real world, and it is part of Leftist ideology to imagine radically different, possible futures aligned around shared moral values.

Dubourg and Baumard argue that imaginary worlds are so successful – drawing the interest and acclaim of many – because they exploit a basic human desire to explore, rather than because of the content they communicate. However, imaginary worlds enable communication and exploration of content that is central to being human: our moral values.

Spending time within imaginary worlds offers two unstated opportunities: First, imaginary worlds help us develop and crystallize our moral worldviews. They offer a stage to share moral lessons and values across time and space, and to form meaningful identity groups around those values. Second, imaginary worlds also allow us to envision new possibilities for our current reality. We can use imaginary worlds to conceptualize a future drastically different from the present – its own kind of imaginary but *possible* world. That is, we argue that imaginary worlds communicate and solidify our moral values, and offer rich landscapes from which we can imagine not just impossible worlds, but ones we can make strive to make possible too.

Engagement with and transfer of moral values is critical to successful complex human societies (e.g., Curry, Mullins, & Whitehouse, 2019; Searle & Willis, 1995; Tomasello, 2009). Imaginary worlds allow for the communication and interrogation across time and space of moral values, which are notably sensitive to psychological distance (see Eyal, Liberman, & Trope, 2008; Mentovich, Yudkin, Tyler, & Trope, 2016). Indeed, even everyday language points to this key function of imaginary worlds: "The moral of the story" is its key takeaway. Aesop's fables convey moral virtues through an imaginary world of talking animals. Fictional stories both convey norms and rules across time and cultures, and create memorable worlds where the reader can safely learn (e.g., through simulation; Mar & Oatley, 2008; Meyer, Zhao, & Tamir, 2019). And this learning is directly applicable to the real world: Imaginary worlds help us define right and wrong in our present reality – even after the story ends.

Writers of imaginary worlds also reveal our moral values by creating fictional universes with alternative manifestations of those same values. The most straightforward examples of these are the dystopian worlds named in Table 1, like *1984*, the *Handmaid's Tale* and *Brave New World.* For example, *1984* presents an element of the present (e.g., war's ability to make violations of civil liberties permissible) in a way we can readily see as morally wrong (e.g., Big Brother). The same can be said of superhero stories with exaggerated exemplars of good and evil (Pizarro & Baumeister, 2013), and science fiction, which often asks us to grapple with moral quandaries that take new forms as technology advances (e.g., Asimov's Three Laws of Robotics). The authors do not include satire as a relevant genre, but one of the most famous satirists, Jonathan Swift, appears in Table 1. In *Gulliver's Travels*, Swift provides a veneer of fiction from which it is safe to confront moral breakdown in the real world. While we agree that imaginary worlds satisfy a need to explore (as the target authors describe), they also help us, separate good from bad (McHugh, McGann, Igou, & Kinsella, 2022; see also Pizarro & Baumeister, 2013), crystallize our own values, and explore concepts like justice, power, and punishment.

When we see imaginary worlds as a conduit for understanding the moral world around us, we also find another explanation for the recent proliferation of imaginary worlds that the authors describe. With increased globalization (i.e., interdependence across countries and cultures) people may have an increased need to understand not just their own moral world, but also how it compares to others.

Indeed, a core function of moral values is to regulate behavior and draw lines around meaningful social groups (Yudkin, Gantman, Hofmann, & Quoidbach, 2021) – as do fandoms of imaginary worlds. Fans readily sort themselves into subcultural social groups within their imaginary worlds aligned with specific values. For example, Harry Potter fans strongly align with their chosen Hogwarts House, each identified by a moral value like bravery. What's more, participation in fan culture can motivate people to bring values from the world of the fandom into the real world. This is the case with fan activism, a participatory practice through which members of a fan community organize around real-world issues (Jenkins & Shresthova, 2012). Fan activists use imagery from their imaginary world as protest symbols. For example, indigenous and Palestinian protestors have used imagery from the movie *Avatar* to convey their message of colonization and land rights (Brough & Shresthova, 2012). The relationship between fandom and activism is also mutually reinforcing: Participating in collective action further solidifies group identity within a particular fandom (Carriere, 2018). This kind of fan-based collective action is an example of how engaging with imaginary worlds can help us picture and work toward a possible, different future, where we better live out our values or even prioritize entirely new ones.

This is especially notable because imagining a world with different moral values is uniquely difficult (Black & Barnes, 2017; Gendler, 2000). One way that Leftist activists have met this challenge is through the practice of radical imagination. Drawing on radicalism as an ideology, which seeks to completely transform existing institutions to achieve an anti-oppression future

(Bötticher, 2017), the practice of imagining a radically different future – cohered around shared moral values (e.g., egalitarianism, solidarity) – fosters collective future cognition and community organizing (Haiven & Khasnabish, 2010; Paulson, 2010; Reinsborough, 2010). Historic and contemporary radical movements have been theorized as organized around the radical imaginations of their participants – co-constructed imaginary worlds that activists first create in their minds (Petersen & Aarøe, 2013), and then work to make real (e.g., Kelley, 2002; Khasnabish, 2008). Here, we also find another explanation for the popularity of imaginary worlds among teens and young adults: They have the most to gain by remedying moral failures in the present.

In sum, imaginary worlds allow us to better understand and develop our moral worldviews. Engaging with imaginary worlds helps us negotiate and solidify our moral values, construct our social identities, and imagine and work toward radically different, but possible futures aligned around shared moral values.

Funding. None.

Conflict of interest. None.

References

Black, J. E., & Barnes, J. L. (2017). Measuring the unimaginable: Imaginative resistance to fiction and related constructs. *Personality and Individual Differences*, *111*, 71–79. https://doi.org/10.1016/j.paid.2017.01.055.

Bötticher, A. (2017). Towards academic consensus definitions of radicalism and extremism. *Perspectives on Terrorism*, *11*, 73–77.

Brough, M. M., & Shresthova, S. (2012). Fandom meets activism: Rethinking civic and political participation. *Transformative Works and Cultures*, *10*. https://doi.org/10.3983/twc.2012.0303.

Carriere, K. R. (2018). "We are book eight": Dialoging the collective imagination through literary fan activism. *Culture & Psychology*, *24*, 529–544.

Curry, O. S., Mullins, D. A., & Whitehouse, H. (2019). Is it good to cooperate? Testing the theory of morality-as-cooperation in 60 societies. *Current Anthropology*, *60*, 47–69.

Eyal, T., Liberman, N., & Trope, Y. (2008). Judging near and distant virtue and vice. *Journal of Experimental Social Psychology*, *44*, 1204–1209.

Gendler, T. S. (2000). The puzzle of imaginative resistance. *The Journal of Philosophy*, *97*, 55–81.

Haiven, M., & Khasnabish, A. (2010). What is the radical imagination? A special issue. *Affinities: A Journal of Radical Theory, Culture, and Action*.

Jenkins, H., & Shresthova, S. (2012). Up up and away! The power and potential of fan activism. *Transformative Works and Cultures 10*, 1–13. doi:10.3983/twc.2012.0435

Kelley, R. D. (2002). *Freedom dreams: The black radical imagination*. Beacon Press.

Khasnabish, D. A. (2008). *Zapatismo beyond borders: New imaginations of political possibility*. Buffalo; University of Toronto Press. doi:10.3138/9781442689695

Mar, R. A., & Oatley, K. (2008). The function of fiction is the abstraction and simulation of social experience. *Perspectives on Psychological Science*, *3*, 173–192.

McHugh, C., McGann, M., Igou, E. R., & Kinsella, E. L. (2022). Moral judgment as categorization (MJAC). *Perspectives on Psychological Science*, *17*(1), 131–152.

Mentovich, A., Yudkin, D., Tyler, T., & Trope, Y. (2016). Justice without borders: The influence of psychological distance and construal level on moral exclusion. *Personality and Social Psychology Bulletin*, *42*, 1349–1363.

Meyer, M. L., Zhao, Z., & Tamir, D. I. (2019). Simulating other people changes the self. *Journal of Experimental Psychology: General*, *148*, 1898.

Paulson, J. (2010). The uneven development of radical imagination. *Affinities: A Journal of Radical Theory, Culture, and Action*. https://ojs.library.queensu.ca/index.php/affinities/article/view/6134.

Petersen, M. B., & Aarøe, L. (2013). Politics in the mind's eye: Imagination as a link between social and political cognition. *American Political Science Review*, *107*, 275–293. https://doi.org/10.1017/S0003055413000026.

Pizarro, D. A., & Baumeister, R. (2013). Superhero comics as moral pornography. In R. S. Rosenberg (Ed.), *Our superheroes, ourselves* (pp. 19–36). Oxford University Press.

Reinsborough, P. (2010). Giant whispers: Narrative power, radical imagination and a future worth fighting for. *Affinities: A Journal of Radical Theory, Culture, and Action*. https://ojs.library.queensu.ca/index.php/affinities/article/view/6140.

Searle, J. R., & Willis, S. (1995). *The construction of social reality*. Simon and Schuster.

Tomasello, M. (2009). *Why we cooperate*. MIT press.

Yudkin, D. A., Gantman, A. P., Hofmann, W., & Quoidbach, J. (2021). Binding moral values gain importance in the presence of close others. *Nature Communications*, *12*, 1–12.

Authors' Response

Imaginary worlds through the evolutionary lens: Ultimate functions, proximate mechanisms, cultural distribution

Edgar Dubourg and Nicolas Baumard

Département d'études Cognitives, Institut Jean Nicod, ENS, EHESS, PSL University, CNRS, Paris 75005, France.
edgar.dubourg@gmail.com

doi:10.1017/S0140525X22000048, e309

Abstract

We received several commentaries both challenging and supporting our hypothesis. We thank the commentators for their thoughtful contributions, bringing together alternative hypotheses, complementary explanations, and appropriate corrections to our model. Here, we explain further our hypothesis, using more explicitly the framework of evolutionary social sciences. We first explain what we believe is the ultimate function of fiction in general (i.e., entertainment) and how this hypothesis differs from other evolutionary hypotheses put forward by several commentators. We then turn to the proximate features that make imaginary worlds entertaining and, therefore, culturally successful. We finally explore how these insights may explain the distribution of imaginary worlds across time, space, age, and social classes.

R1. Ultimate function: Why do people produce and consume fictions with imaginary worlds?

We share with most commentators the idea that the cultural evolution of fiction is best explained using an evolutionary framework, by asking what are the proximate mechanisms and the ultimate function of the mechanisms which are involved in the cultural success of fictions. However, we discovered that several commentators favor the idea that the function of fiction is to get new information (through simulation or social learning). By contrast, our hypothesis states that the function of fiction is, for the producer, to entertain other people and, for the consumer, to get the social benefits of sharing entertainments with others. This hypothesis is central in our paper. It is, thus, necessary to explain it further before moving to the special case of imaginary worlds.

R1.1. The entertainment hypothesis

Using the standard framework of social evolution theory (Hamilton, 1964), we first consider the point of view of the producers of fictions (the agent), before turning to the consumers of fictions (the recipient).

R1.1.1. What benefit for the producers?

As **Lightner, Heckelsmiller, and Hagen** (**Lightner et al.**) note, building an imaginary world is costly: it is time-consuming and

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

brings along important opportunity costs. What then is the adaptive benefit, and thus the ultimate function of producing imaginary world? Today, it is widely agreed that the success of imaginary worlds is primarily driven by the entertainment industry (e.g., the book industry, the gaming industry, and the film industry). The entertainment industry gets benefits from advertisement, as well as through ticket sales and subscriptions. As Lightner et al. rightfully note, this is also the case for creators who get benefits from selling fictional stories as well as merchandising products derived from their stories.

We contend that this observation should be taken seriously. If, today, imaginary worlds give benefits to their creators because there is a benefit in entertaining people, then this could also be the case outside highly modern societies. In line with this idea, in every society, storytellers, singers, and writers enjoy some kinds of benefits. As **Lightner et al.** observe, a fictional storyteller can, thus, be considered as a specialist, just like healers, shamans, or tool makers, who "invest their life's work in cultivating high levels of expertise in some domain (e.g., medicine, astronomy)" and get the benefits associated with the service they provide. This explains why the producers' goal to entertain their audience lead them to target and include appealing fictional content features such as imaginary worlds: because that is the best way to attract a bigger audience and increase their fitness. We are not arguing that producers of fictions are just looking to become rich and famous. At the proximate level, we assume that they mostly want to create good, interesting, and enjoyable fictional stories. The ultimate level explains why this is the case: because grabbing others' attention leads to fitness benefits.

This may also explain why fans create video game mods or literary fanfictions: Just as the initial creators of the imaginary world, they may attract an audience and get the benefits of entertaining people (**Rodríguez-Fuentes & Ulloa**). It is important to note that we are not committed to the view that there is a specific adaptation to invest in entertaining, just as there is no adaptation to invest in car making, academic scholarship, or shamanistic practices. We are agnostic as to whether humans evolved an "adaptation to entertain others" in the way that some have hypothesized an adaptation to produce and consume music (Mehr, Krasnow, Bryant, & Hagen, 2020). We think that such an adaptation is not necessary to explain the existence of fictions. Humans are naturally endowed with capacities for language, mindreading, and simulation, that are recycled in creating fiction (as noted by **Hogan**; **Moore & Hills**; **Oatley**). They have also evolved cognitive capacities to evaluate the potential fitness benefits (e.g., in resources and in prestige) of various goal-oriented activities (Cosmides & Tooby, 2013; Singh, 2020). In this perspective, it is straightforward that they use their cognitive skills (e.g., language, mindreading, and simulation) to invest in entertainment when the social context is favorable to this activity.

R1.1.2. What benefit for the consumers?

The benefit for the consumers might look more mysterious. Why loose time and resources in listening to stories? To understand the benefit of entertainment for the consumers, it might be useful to turn again to modern societies. As many noted by several commentators (**Gabriel, Green, Naidu, & Paravati [Gabriel et al.]**; **Goldy & Piff**; **Wilbanks, Moon, Stewart, Gray, & Varnum [Wilbanks et al.]**; **Wolf**; **Wylie, Alto, & Gantman [Wylie et al.]**), consuming entertaining cultural items can be advantageous for several social reasons. Consuming fictions can be used to signal preferences, competences, and wealth, as long noted by social scientists (Bourdieu, 1979; Veblen, 1899). Consuming fictions can also be used to coordinate with others: Discussing fictions in a diner and going to the theater allow individuals to have enjoyable interactions with others, leading to more beneficial interactions. (e.g., finding mates, strengthening friendship, building partnership, detecting potential allies; Dubourg, André, & Baumard, 2021a, 2021b; Dubourg & Baumard, in press). All these fitness-enhancing activities are made easier when people are entertained.

Again, we are not committed to the idea that humans have evolved an adaptation to "like being entertained" so that they can signal their competences or have fun with friends. Rather we contend they have evolved cognitive abilities to detect situations, activities, and places that help them further their social life and advance their fitness goals "as they would (for) any other economic resource in a market setting" (**Lightner et al.**). This, obviously, is not specific to fictions, but to several cultural activities or productions such as sport, parties, or music. People engage in these activities because they perceive the potential benefits (e.g., meeting potential mates and meeting friends).

R1.2. Comparing the entertainment hypothesis and the information hypothesis

If fictions mostly exist because they entertain people (which brings benefits to both the producers and the consumers), then it means that the main causal factors of the contents of fiction are *people's preferences*. Here, the situation is very similar to the evolution of signaling in non-human animals (e.g., courtship parades, feathers, and nests). In non-human animals, the main causal factors of the content of signals are the sensory preferences of the receiver (Barrett, 2010; Enquist & Arak, 1994; Krebs & Dawkins, 1978; Lorenz, 1966; Verpooten & Nelissen, 2010). For instance, the female frog *Physalaemus pustulosus* had pre-existing preferences for lower-frequency chuck sounds, and then males evolved the ability to produce such sounds to exploit this sensory preference (Ryan, Fox, Wilczynski, & Rand, 1990). In non-human animals, this recycling usually emerges by natural selection. In humans, it can emerge through cultural evolution: Producers target and refine stimuli that are already appealing to consumers. Thus, we completely agree with **Lightner et al.** that, when consumers have strong exploratory preferences, producers should consider investing time in the creation of imaginary worlds.

This hypothesis differs markedly with the informational hypothesis according to which fictions exist because consuming fictions leads to improving cognitive capacities, transmitting fitness-related information, or simulating real-life events (**Gabora & Gomez**; **Goldy & Piff**; **Moore & Hills**; **Nissel & Woolley**; **Pianzola, Riva, Kukkonen, & Mantovani [Pianzola et al.]**; **Scrivner & Clasen**; **Scalise Sugyiama**; **Sitek & Konieczna**; **Wilbanks et al.**; **Wylie et al.**). To take a concrete example retrieved from a commentary, **Beck and Harris** write that "when children read Harry Potter, they are learning about personal relationships and morality, as well as the rules of Quidditch."

First, it seems to us that if the goal had been to teach things about personal relationships and morality, there would be more straightforward ways than inventing a whole imaginary world (and rules for an imaginary sport). More precisely, the information hypothesis fails to explain why producers of fictions invent and exaggerate stimuli to the point that they resemble less and less reality (more on the exaggeration of stimuli in sect. R2). For instance, while pedagogy may sometimes require simulations with exaggerated situations (e.g., a flight simulator should train

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

the individuals to difficult but plausible flight situations), flying on broomsticks is a fictional feature that cannot be explained as a simulation device, because it does not train consumers to any possible situation. Yet, the existence and cultural success of Quidditch deserves a causal explanation. We argue more generally that the invention and exaggeration of stimuli in fictions can be evidence that fictions might not be suited to simulate the real world (Morin, Acerbi, & Sobchuk, 2019).

Second, the empirical results in favor of the information hypothesis are ambiguous. Sure, people who read fictions tend to have higher mindreading abilities, but the direction of causality is unclear: It could be that consuming fiction leads to developing mindreading abilities, which corresponds to the information hypothesis (Black & Barnes, 2015; Castano, 2021; Kidd & Castano, 2013; Zunshine, 2006), or more parsimoniously, that people who are good in mindreading and like understanding other's lives are more entertained by fictional stories about the lives of fictional people, and thus are more likely to read fictions (Panero et al., 2016). The entertainment hypothesis makes the latter interpretation of such correlational results.

To take an example closer to our article, Scrivner, Johnson, Kjeldgaard-Christiansen, and Clasen's study (2021) provided interesting evidence of correlations between consuming horror fictions and psychological resilience toward the COVID pandemic (**Scrivner & Clasen**; **Wilbanks et al.**). They conclude that consuming horror films benefits the consumers "through preparation and practice of both specific skills relevant to particular situations and more general skills associated with emotion regulation." But there is another explanation, that is fully compatible with their results. It could be the case that people *already* more psychologically resilient to stress (e.g., because of genetic and ecological factors) would be fonder of horror movies.

To take yet another example, let's think of love stories: It seems much more parsimonious to state that more romantic people enjoy more reading romantic fictions than to hypothesize that *consuming* romantic fictions *makes* people more romantic. Therefore, we argue that, within this debate about causal effects, the burden of proof falls on those who advocate that consuming cultural artifacts has causal effects on other behavioral or cognitive traits (and not the other way around). And we argue that such causal evidence is as of now far from being convincing.

R1.3 Mixed products: Edutainment, religious myths, and folktales

So far, we have opposed the "entertainment hypothesis" and the "information hypothesis." But they are not mutually incompatible. Several commentators observed that imaginary worlds are also present in works that are less fictional: oral traditions, folktales, myths, and religious narratives (**Arnett**; **Dunk & Mar**; **Moore & Hills**; **Scalise Sugiyama**; **Sugiyama**; **Wiessner**). We agree with them that oral traditions, folktales, myths, and religious narratives often include imaginary worlds. Yet we think that they are not produced and consumed for the same reasons, that is, to fulfill the same fitness-related goals.

For instance, religious beliefs about supernatural agents (e.g., gods, spirits, and ancestors) are probably produced by specialists (e.g., shamans) who gain in selling their services to people who believe in their supernatural capacity to communicate with supernatural agents (Boyer, 2020; Singh, 2018). In the same way, religious myths about supernatural punishment are probably produced, transmitted, and supported by the members of the community because they evaluate that the threat of supernatural punishment can deter cheating and increase group solidarity (just as the same people would support a police force or a judicial system; Baumard & Chevallier, 2015; Fitouchi & Singh, 2021). Producers of fictions can also invent narratives to transmit some fitness-related information, leading to educational narratives (Scalise Sugiyama, 2011) or what is called today edutainment (Anikina & Yakimenko, 2015; Singhal, 2004). Crucially, imaginary worlds invented to control others' cooperation, transmit some fitness-related information, and entertain people won't be successful for the same reasons and won't be composed of the same content features.

Of course, narratives which do not aim at entertaining can contain entertaining features, such as supernatural entities, because they make the narratives overall more attention-grabbing (Fig. R1). But the strategic incentives of the producers (e.g., to control other's cooperation) lead them to preferably include features that more specifically fulfill their goal (e.g., *punishing* deities; Fitouchi and Singh, 2021). By contrast, when the strategic goal of producers is to entertain other people, they preferably include features that tap into people's preferences.

To sum up, we believe that the "information hypothesis" alone does not explain why humans invent *fictional* narratives that depart from real facts, real social events, real persons, and real settings. If information transmission was the sole (or most important) goal of producers, they wouldn't incorporate fictional entertaining contents to their narratives. Scalise Sugiyama (2005, 2021) acknowledged this is a puzzle, and proposed that facts are mixed up with invented features because such features are (1) fully recognized as such (through the use of pragmatic cues observable across cultures and in small-scale societies) and (2) attention-grabbing and memorable (providing better learning opportunities). Our general framework, in fact, agrees with this view and asks the question *why and how such specific features are attention-grabbing* to the human mind.

R2. Proximate mechanisms: What are the psychological forces behind the specific features of imaginary worlds?

R2.1. Exploratory preferences explain the existence and the content of imaginary worlds

R2.1.1 Exploratory preferences explain the existence of imaginary worlds

Some commentators argued that our definition of an imaginary world was somehow vague (**Arnett**; **Llewellyn**; **Norman & Goldstein**; **Salmon & Burch**; **Shtulman**; **Sobchuk**). This is not because we do not want to be analytical, it is because imaginary worlds are a product of the human mind: Our definition corresponds to the "actual domain" (Sperber & Hirschfeld, 2004) of exploratory preferences, that is, to all the settings that trigger them (Fig. R2). This preference for exploration has evolved in all humans because exploring the local environment leads to discover new resources, new mates, or new habitats, for example, and therefore brings about fitness benefits to the individuals. We hypothesized that this preference is activated by cues indicating that the environment is unknown and that these cues are exaggerated in fictions with imaginary worlds. Such cues include landscapes that are visually different from any landscape one knows (e.g., Hyrule's landscapes in *Zelda*), representations of a delimitation between the known and the unknown (e.g., the walls from *Attack on Titan*), new location names (e.g., Hogwarts in *Harry Potter*), and novel world-related information (e.g., the nine-headed phoenix from *The Classic of Mountains and Seas*). We contend that these cues (indicating to the consumers that the

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

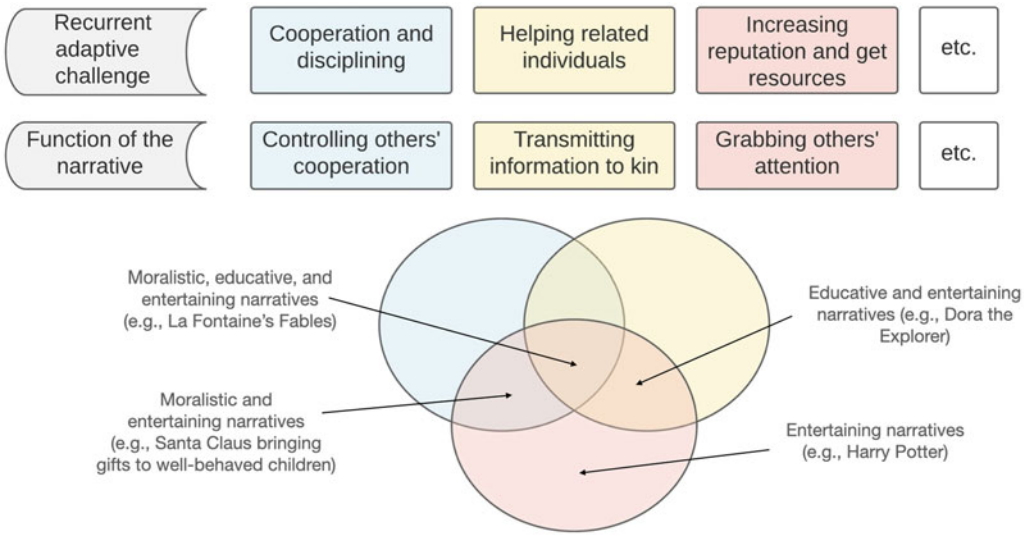

Figure R1. Examples of functions of fictional narratives related to recurrent adaptive challenges, and their possible interactions. The red area represents purely entertaining fictions (even if, locally, there can be moralistic or educative features in *Harry Potter*). At the intersections, we observe mixed products. For instance, Santa Claus bringing gifts to well-behaved children is undoubtedly a moralistic fictional narrative, which ultimately aims at disciplining. As a matter of fact, in most oral narratives from early modern and modern Europe (in the Holy Roman Empire), Saint Nicholas was accompanied by a foil threatening to trash disobedient children (e.g., "Knecht Ruprecht" in Germany; "Krampus" in Austria; "Parkelj" in Slovenia, Croatia, and Hungary). *Dora the Explorer* is at the intersection of education and entertainment because Dora directly teaches children how to speak and count. Finally, some narratives can be moralistic, educative, and entertaining, as exemplified by La Fontaine's *Fables*.

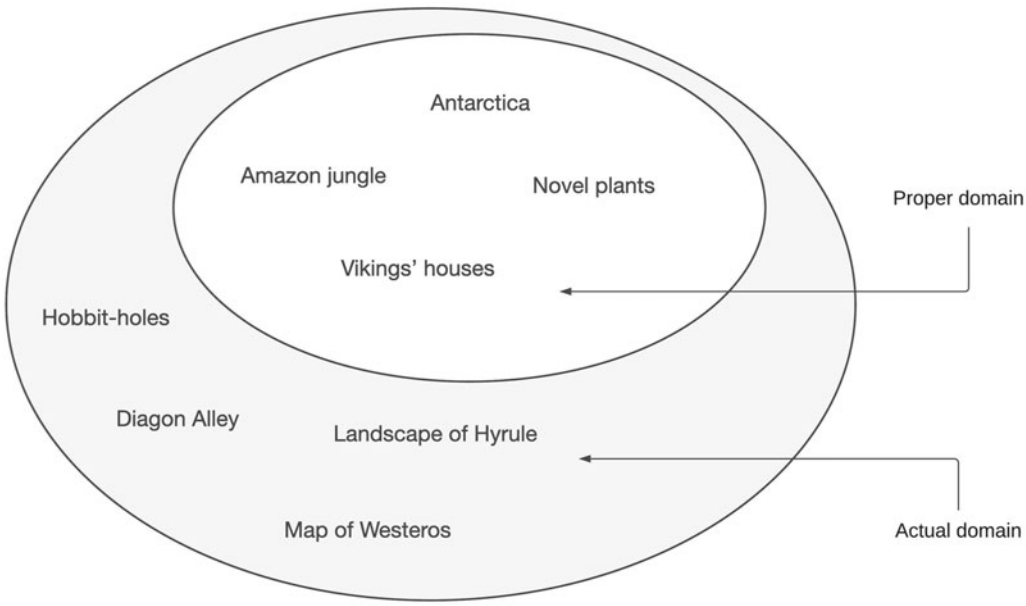

Figure R2. Exploratory preferences, with their proper domain (i.e., cues that an environment is unknown, e.g., unknown landscapes) and their actual domain (i.e., all stimuli mimicking cues that a setting is unknown, e.g., imaginary landscapes). Based on Sperber and Hirschfeld (2004).

fictions they are consuming are taking place in an imaginary world) trigger exploratory preferences.

This makes the definition specific enough to distinguish imaginary worlds from other (sometimes related) stimuli. For instance, we believe that the world of Balzac is not an imaginary world. Balzac invented 3,000 characters, but his novels do not inspire the same degree of curiosity, because the world in which they take place (e.g., its geography, its functioning, and its rules) is already well known to the readers.

Note that this apparent problem of definition is not specific to imaginary worlds. We believe that the appeal of fictions all around the world is explained by the presence, in fictions, of a myriad of already appealing stimuli that producers use and exaggerate to enhance the attraction of the overall product. Such *specific* stimuli are appealing because they tap into *specific* preferences. The level of granularity of a fictional content feature (**Sobchuk**), therefore, depends on the specificity of the cognitive preference it is associated with. For instance, romance can be

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

defined as a fiction based on a long-term relationship (Baumard, Huillery, & Zabro, in press). What is a "long-term relationship"? This seems loose. It is not because it is based on the notion of pair-bonding, a specific adaptive behavior that evolved among monogamous species for which parental care is important (Fletcher, Simpson, Campbell, & Overall, 2015).

R2.1.2. Exploratory preferences explain the content of imaginary worlds

Cues of imaginary worlds are included in fictions by producers because they are already attention-grabbing stimuli to the human mind. But it is important to bear in mind that producers also exaggerate such stimuli in fictions, making them even more attention-grabbing. This is what has been called superstimuli (Tinbergen, 1969) or supernormal stimuli (Nettle, 2005a, 2005b). Cultural superstimuli are a specific case of cultural attractors which are successfully transmitted and stabilized in human cultures because they are intentionally made more attractive to the human mind (by human minds). While cultural products can be exaggerated in that way (e.g., diaries; Morin et al., 2019), we argue that fictions, being invented narratives, are specific: They can include virtually any superstimulus that one can think of, making it the ideal field to study superstimuli and cognitive preferences. We can, for instance, look at the *direction* of the exaggeration transforming a stimulus into a superstimulus, so as to infer the preference it taps into. For instance, Mickey is a highly popular protagonist. Across the last decade, his eyes have become more doting and his head larger. Why? We can explain this evolution of the shape of Mickey with our evolved baby-face detection system, which makes us like juvenile facial features. Proximally, this is a preference for "cuteness" (Glocker et al., 2009a, 2009b). Therefore, because Mickey progressively became cuter and cuter, we can infer that Mickey's face is a superstimulus taping into our evolved preference for baby faces (Gould, 2008; Hinde & Barden, 1985).

Superstimuli are different from normal stimuli, but this difference is a matter of degree. For instance, competent protagonists are appealing in fictions (Singh, 2021). But *highly* competent protagonists are *highly* appealing. This is how we explain superpowers such as Superman's strength or ability to fly: it is a superstimulus of competence. If imaginary worlds tap into the human preference for spatial exploration, they can be viewed as *superstimuli of explorable worlds*. Actually, our theory predicts that fictions with *non*-imaginary foreign worlds, such as fictions being set in Asia for Western consumers, or fictions in distant history (**Sobchuk**), are also successful because of our exploratory preferences. Just as competent protagonists are also successful. Imaginary worlds are to explorable fictional worlds what superpowers are to competency. However, our theory does hypothesize that superstimuli (e.g., imaginary worlds and superpowers) are more appealing and entertaining compared to normal stimuli (e.g., unknown places and competency). This dimension of the hypothesis makes the prediction that there is a competition between both versions of the same stimulus (the normal stimulus and the superstimulus) because (1) the superstimulus (e.g., an imaginary world) has been cumulatively refine to better tap into the associated preference (e.g., exploratory preferences), and (2) both versions should be popular among the very same people (because they actually tap into the same preference). More specifically, here, we predict that fictions with imaginary words are becoming more and more successful, *at the expense of historical fictions and fictions set in foreign countries*.

R2.2 Exploratory preferences also predict the content features of imaginary worlds that are unrelated to exploratory preferences

Imaginary worlds are a difficult stimulus to isolate, in that respect: Producers can mix imaginary worlds with virtually any other content feature, making it even more difficult to disentangle them. Besides, some stimuli are often found associated together in fictions (more than chance would predict). For instance, imaginary worlds are often associated with dichotomic representation of good and evil. In our view, this does *not* mean that they constitute the same stimulus, or that they tap into the same cognitive preference. Rather, we hypothesize that some cognitive preferences are evoked by the same factors (e.g., ecological cues and the life stage), so that stimuli that activate such preferences are likely to be found in the same fictions. For instance, because adolescents are (1) reaching puberty (Del Giudice, Angeleri, & Manera, 2009), (2) more risk-taking (Bakerjr & Maner, 2008; Steinberg et al., 2018), and (3) still highly explorative (Ciranka & van den Bos, 2021), we predict that love-related stimuli, risk-related stimuli, and imaginary-world-related stimuli will tend to be associated in fictions (way more than chance would predict it), because a love story with a dangerous imaginary world would be a popular combination among a big potential audience (i.e., the adolescents). The evolutionary study of *clustered* features in fictions is a different research program which could be very promising in the near future. On that note, this is how we explain the bigger success of *The Lord of the Rings* over *The Silmarillion* (a puzzle rightfully highlighted by **Pianzola et al.**). While the "imaginary-world stimulus" may be stronger in *The Silmarillion*, *The Lord of the Rings* succeeds in combining a greater variety of appealing stimuli (e.g., Frodo's quest and Frodo's friendship with other protagonists).

R2.3 Fictions with imaginary worlds trigger several preferences, but only exploratory preferences are specific to imaginary worlds

We do not deny that fictions with imaginary worlds also tap into other preferences (see Fig. R3), but we contend that fictions with imaginary worlds require the existence of exploratory preferences. Threat detection, romantic love, and social skills, for example, can lead to the invention of all kinds of fictions, but not to the full development of imaginary worlds.

R2.3.1. Imaginary worlds are not social worlds

Some commentators tried to support or challenge our hypothesis by mentioning the appeal for social exploration. For instance, commentators brought evidence that people like (1) to embody avatars that are different from themselves (**Szolin & Griffiths**), (2) to read about fictional characters who are morally ambiguous and deceive other people (**Scalise Sugiyama**; **Wiessner**), (3) or conversely to read about extremely good or evil characters (**Wylie et al.**), and (4) to read about the protagonists' internal thoughts (**Pianzola et al.**; **Winner**). We argue that these content features are not directly related to imaginary worlds, because they do not require an imaginary world to exist in a fiction. We believe that such stimuli are definitively worth studying within our framework, but as separate stimuli which would, therefore, tap into different evolved preferences (e.g., for detecting cheaters or potential good cooperative partners).

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

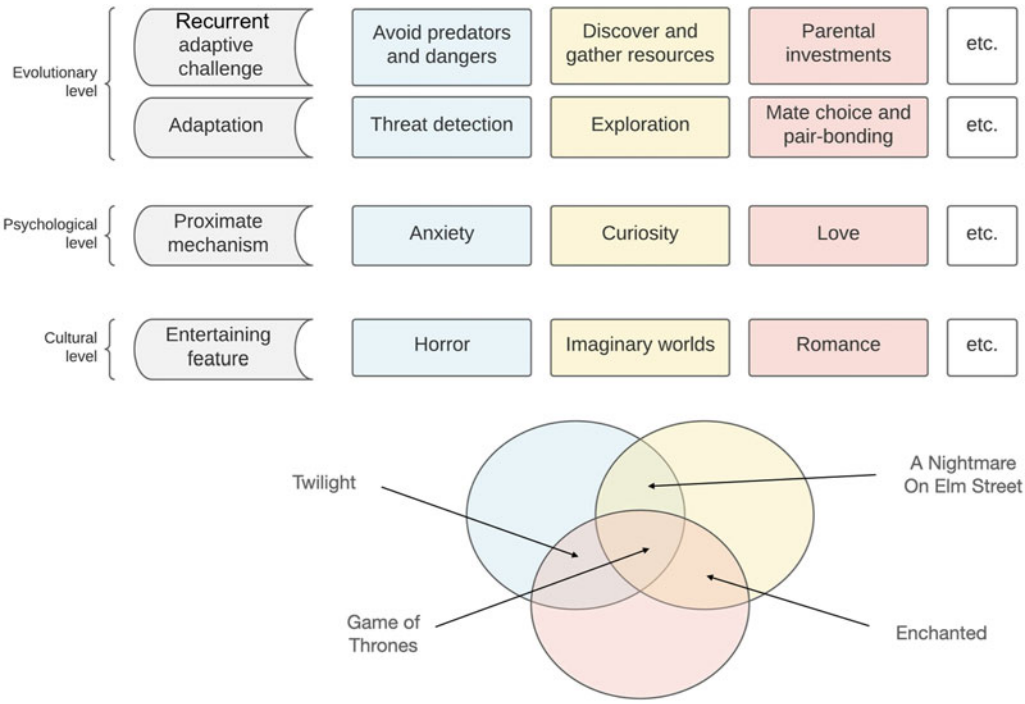

Figure R3. Three examples of three entertaining features in fictions (cultural level) with the proximate mechanisms they co-opt (psychological level) and the ultimate functions of these mechanisms (evolutionary level), and their possible interactions.

R2.3.2. Imaginary worlds are not minimally counterintuitive worlds

Some commentators rightfully mention that imaginary worlds are often filled up with strange content features which grab our attention, such as part-animal part-human protagonists (**Wiessner**), "talking animals, flying carpets, time-traveling wizards" (**Shtulman**), or human transformation into supernatural beings (**Scalise Sugiyama**). Such stimuli can be associated with our strict definition of an imaginary world by stating that they point to the consumers that the setting of the fiction may well be an imaginary world. But this is not necessarily the case. Let's think of fictions in which such features are described within a known location of the real world. For instance, Meyer's *Twilight* includes immortal vampires and is yet set in a real city (Fork, Washington), in the real world. Consistently, such stimuli do not strike us as necessarily feeding the human desire to explore their environment. As Shtulman explains it, such stimuli are appealing stimuli in themselves, because they violate core intuitions we have, for instance about biology (e.g., biological beings are mortal) and physics (e.g., objects don't fly or don't go through walls). These beliefs are so intuitive that fictional features that break them constitute highly entertaining stimuli *even in a faithful representation of the real world* (Banerjee, Haque, & Spelke, 2013; Boyer, 2001; Boyer & Ramble, 2001; Norenzayan, Atran, Faulkner, & Schaller, 2006; Stubbersfield & Tehrani, 2013). In the same way, we argue that studies mentioned by developmental psychologists focus not on imaginary worlds (defined as cues that the fictional setting is unknown) but on minimally counterintuitive content features, such as characters walking through walls (**Weisberg & Sobel**), or invisible objects (Barnes, Bernstein, & Bloom, 2015; **Beck & Harris**).

R2.3.3. Imaginary worlds are not (just) storyworlds

We agree with **Pianzola et al.** that the feeling of presence and the self-perception of skillful agency are appealing in fictions, and that this is highly related to imaginary worlds. For instance, the sequentiality of events in fictional narratives allows to describe protagonists moving through the imaginary settings and to provide consumers with progressive descriptions or visual depictions of space that make us feel agent of this unknown world. It activates a preference for controlling one's own actions and events (Haggard & Chambon, 2012), in addition to the preference for exploration. As the commentators state it, although, this feeling of presence is not specific to imaginary worlds because it is a component of virtually all fictional storyworlds. Therefore, it cannot explain alone why imaginary worlds emerged and why they are so successful. That being said, we agree that such a feeling is enhanced in imaginary worlds. This is clearly observable in open-world video games taking place in large imaginary worlds: Consumers of such fictions are driven by the possibility to interact and move within the imaginary world, making it seem as they constitute the same appealing stimulus. We argue that it is important to disentangle them and study them apart in the first place, before considering studying them together.

R2.3.4. Imaginary worlds are not (just) frightening worlds

Scrivner and Clasen state from the beginning that morbid curiosity is an "additional factor" explaining the cultural evolution and success of imaginary worlds. We completely subscribe to their proposition that horror stimuli in fictions, such as dark places, monsters, or dangerous situations, activate our threat detection systems (while we are more skeptical that people read or watch horror fictions to be better prepared to face danger in the real world; see sect. R1.2.1). However, while horror stimuli are very often found in imaginary worlds, we do not think that they are specific to them. One can consume a fiction with a dark forest and a killer, find it entertaining, but not conclude that the fiction takes place in an imaginary world. Consistently, we have the

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

intuition that such stimuli (e.g., a dark forest and a killer) don't fuel our lust of exploration, the way large unknown landscapes do. Of course, both features go along well: Middle-Earth is both an imaginary world and, sometimes, a frightening world filled with Orcs, so that it combines two powerful attractors. And there seems to be several other fictions after *The Lord of the Rings* which associated imaginary worlds and frightening stories. This is, we think, a combination that is worth exploring in future research.

R2.3.5. Imaginary worlds may well be organized worlds

This is a possibility which we only briefly mention in the Discussion of the Target Article, and which would have deserved more investigation. As such, we were pleased and interested to read **Browning and Veit**'s commentary about autism and the preference for imaginary worlds. Actually, we agree that the drive to systemize (defined as a drive to "*explore* a system" by Baron-Cohen, 2003) may be very closely related to the preference for spatial exploration. We propose here a way to incorporate this explanation to our hypothesis, and, in doing so, to consistently explain why items in imaginary worlds such as lists of location names or maps, are likely to be considered as cues that the imaginary setting is worth exploring (and to activate our preference for exploration). The proposition is to bring together three theories of exploration and curiosity, by stating that exploration allows foraging new resources, important resources, and better ways to explore further (and discover new and important resources). This explains the curiosity for new things (i.e., novelty-based exploration; e.g., Berlyne, 1950; FitzGibbon, Lau, & Murayama, 2020; Litman, 2005; Wade & Kidd, 2019), the curiosity for important things (i.e., value-based exploration; Dubey & Griffiths, 2020; Dubey, Griffiths, & Lombrozo, 2020; Spitzer & Kiesel, 2021; Stojic, Analytis, Schulz, & Speekenbrink, 2020), and the curiosity for complex, yet-to-understand things (i.e., systemizing, defined as the drive to explore a system; Baron-Cohen, 2003, 2006, 2009; Greenberg, Warrier, Allison, & Baron-Cohen, 2018). We are currently launching an experimental study to test several predictions that our hypothesis makes, and we will include in the paradigm the Systemizing-Quotient questionnaire (Ling, Burton, Salt, & Muncer, 2009; Veale & Williams, 2017; Wakabayashi et al., 2006), to test Browning and Veit's prediction that people who systemize more are more attracted to imaginary worlds. Incidentally, we also predict that men are overall more attracted to imaginary worlds, because such worlds are likely to be highly explorable systems, as opposed to character-oriented stories which are more attractive to women (Browning & Veit; **Salmon & Burch**). As Salmon and Burch imply it, this could be tested by quantifying which feature each sex focuses on and extend or modify when writing fanfictions from canonic fictions with imaginary worlds. We predict that male consumers (or more systemizing people) will target more world-related features (e.g., extending the information about a location) whereas female consumers (or more empathizing people) will target more character-related features (e.g., modifying the relationships of the protagonists). This addition to the theory also leads to a prediction as to why people like to re-consume fictions with imaginary worlds (**Dunk & Mar**; **Gabriel et al.**): Because highly exploratory people are likely to be (hyper-)systemizers, so that they want to understand everything about the imaginary world (Browning & Veit).

R2.3.6. Conclusion: What is an imaginary world?

To conclude this sub-section, we argue that several stimuli that commentators mention are not constitutive of imaginary worlds. This does not mean that the explanations reported in this sub-section are not interesting and important. This does not mean that they are not fully compatible with our hypothesis either. However, according to us, this means that most explanations don't focus on the right features to explain the cultural evolution and success of imaginary worlds. They explore why fictions with imaginary worlds are successful with elements that are shared by both fictions with imaginary worlds and fictions with no imaginary world. That is, they don't explain how the *specificity of imaginary settings* contributes to the success of fictions with imaginary worlds, or why imaginary worlds appear at all in cultural history.

R3. Distribution: What explains the distribution of imaginary world across age, time, space, and social classes?

R3.1. Changes in consumers' preferences, not producers' skills

The line of argument in the previous sections clears up some misunderstandings about our general hypothesis. For instance, **Wolf** rightfully mentions that imaginary worlds have actually existed for a long time (see also **Dunk & Mar**; **Moore & Hills**; **Scalise Sugiyama**; **Wiessner**). Yet this observation does not contradict our general hypothesis that the appeal for imaginary worlds relies on exploratory preferences and that this appeal increased as people's exploratory preferences increased. Importantly, we never argued that producers "lacked the cognitive abilities to create elaborate and inventive imaginary worlds of substantial size and with considerable amounts of world data" (we agree with Wolf that they did *not* lack such abilities), but rather that *consumers* lacked strong exploratory preferences to find such imaginary worlds entertaining. We, therefore, argue that past literary authors could (and did) produce inventive imaginary worlds, but that such fictions were relatively fewer in number, and relatively poorer in details, than in modern societies, precisely because they were less popular given the preferences of the people at the time. Let's note also that what matters for our theoretical framework is the cultural success at the time the fictional work is released, not their later success or influence.

As a matter of fact, the question is: Who consumed such fiction with imaginary worlds from earlier times? In our article, we explained why and how, in most species (including humans), the strength of exploratory preferences is linked to the level and steadiness of resources in local ecologies. At the individual level, such ecologies differ within a given society, because economic and material resources greatly vary from one family to another, with the best proxy being their economic status. Our hypothesis makes the prediction that imaginary worlds could be culturally successful in past societies, but only with richer individuals (i.e., only with a small fraction of the potential audience). Of course, this prediction is hard to test because, until recently, richer people were the only ones who could both buy books and read, and therefore the only ones who consumed literary works (Kaestle, 1985; Schofield, 1973; Stone, 1969), so that we can't compare their consumption of fictions with the consumption of fictions of poorer people (as **Winner** rightfully suggests we should do). More precisely, there might not be enough *variance* in the economic status of readers from the past to test our hypothesis with historical data at the individual level. However, we can test

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

that, at the *population level*, when a given society gets richer, people in this society express on average stronger exploratory preferences (because the overall environment is both more secure and more affluent), and eventually become fonder of imaginary worlds. This prediction is, therefore, fully consistent with the observations that imaginary worlds culturally emerged (1) before contemporary times, with the examples of More's *Utopia* and Defoe's *Robinson Crusoe* (mentioned by **Wolf**), and (2) outside Western countries, with the examples of the tales of Coyote's travels (mentioned by **Wiessner**) and the Chinese *Classic of Mountains and Seas* (fourth century BC).

Finally, while **Buttrick and Oishi** agree with our hypothesis that consumers' exploratory preferences explain the evolution and success of imaginary worlds, they challenge the hypothesis that the *variability* of such preferences can be ultimately explained with adaptive phenotypic and developmental plasticity. However, the disagreement does not seem that deep: We agree with the commentators that our drive to explore tracks proximate socioecological cues and adapt to them. And we agree that the motivation to go sightseeing and visiting foreign places should be correlated with the motivation to consume fictions with imaginary worlds (both behaviors being driven by exploratory preferences). However, we disagree with the hypothesis that the preference (or possibility) to move *causes* the preference for imaginary worlds. According to our theoretical framework, both are effects of a cognitive preference for spatial exploration, which adaptively varies according to ecological conditions. Both hypotheses make more or less similar diachronic predictions about correlations between different variables (e.g., the evolution of the rate of tourism and the evolution of the prevalence of imaginary worlds in fictions). However, our evolutionary hypothesis makes at least two predictions that their socioecological hypothesis doesn't: (1) that, synchronically, in the same society, people with higher socio-economic status are more exploratory and hence consume more fictions with imaginary worlds than people with lower socio-economic status, *even if they don't travel more* (a variable that can be controlled for); and (2) that children are more explorative and hence consume more fictions with imaginary worlds (even if they don't travel; see sect. R3.2). Only further empirical research about the variability of fiction consumption across modern population can settle this debate.

R3.2. Children's preferences, not their abilities

Now that our framework is better defined, we can address a point of divergence between our general hypothesis and commentaries from developmental psychologists (**Beck & Harris**; **Norman & Goldstein**; **Nyhout & Lee**; **Weisberg & Sobel**). According to us, this point of divergence stems from the same misunderstanding that we reviewed in the latter section: They consider (more or less explicitly) that children's skills should somehow drive the cultural evolution of children fictions. It is all the more important to clarify this point as we believe that developmental predictions derived from our framework could be both highly specific and straightforwardly testable. As we argue elsewhere (Dubourg & Baumard, in press), this framework (bringing together cultural attraction theory and adaptive developmental plasticity) could explain the presence and absence of a myriad of content features in fictions, by considering the age of their targeted audience. Why? Each human life stage from infancy to old age, and including childhood, juvenility, adolescence, and adulthood, is endowed with age-specific preferences (Bjorklund & Pellegrini, 2000; Del Giudice et al., 2009), because natural selection has favored individuals who are able to adopt an optimal scheduling of preferences (Gangestad & Kaplan, 2015; Hill, 1993; Kaplan & Gangestad, 2005). Because our general framework suggests that the cultural evolution of fictions is driven by the consumers' preferences, we can derive a series of predictions about the distribution of content features in fictional narratives by considering the age of the people who find them entertaining (Dubourg & Baumard, in press).

Coming back to the specific case of the appeal for imaginary worlds, we maintain that our hypothesis doesn't make any prediction about "how children imagine" (**Weisberg & Sobel**) or about whether children are "imaginative" or not (**Beck & Harris**; **Norman & Goldstein**; **Nyhout & Lee**; Weisberg & Sobel). We don't claim that "children appear to be both highly exploratory and highly imaginative" (Beck & Harris) but rather that children appear to be highly exploratory and hence *highly receptive to content features triggering exploratory preferences in fictions*. This is why we make the prediction that, if imaginary worlds do co-opt exploratory preferences, they should be popular among children. Studies reported in the commentaries never test the specific predictions that children enjoy imaginary worlds more than adults do. For instance, Barnes, Berstein, and Bloom's (2015) seminal study and the following related studies (e.g., Taggart, Heise, & Lillard, 2018) show that the attraction toward fiction varies with age, with younger people being less drawn to fictional over realistic narratives (or activities). This doesn't go against our theory, which would rather state that *when* children actually decide to consume fictions, their cognitive preferences (such as their exploratory preferences) drive what they like and want to consume. Nyhout and O'Neill' (2017) study shows that following the characters' movements in a story can be difficult for children. Likewise, this is no evidence against our hypothesis because the study focuses on children's *abilities*, not children's *preferences*. This is, we argue, one major issue that prevents us from using results from such otherwise important studies to investigate children's specific preferences.

We could not agree more with the limitations highlighted in the commentaries with regard to the possible ways to empirically test developmental predictions derived from our hypothesis. Studying children's actual preferences with fictional content is difficult. Parents influence children's fiction consumption (**Nyhout & Lee**; **Weisberg & Sobel**), and further research should investigate to what extent before drawing any conclusion from the analysis of consumption data. Besides, market data (1) often don't include data on children's consumption (Nyhout & Lee), (2) never include indicators of success such as ratings by children, and (3) are hard to find in developing countries and in small-scale societies (**Norman & Goldstein**). Only laboratory research with children could allow studying actual children preferences, and to test more specifically the prediction that children are actually fond of imaginary worlds when they are consuming fictional stories.

R.4. Conclusion: More and better cultural databases

We couldn't agree more with **Dunk and Mar** that our theoretical model is not yet supported by enough empirical evidence, and that we need more and better data (Dunk & Mar; **Winner**) and better proxies (Dunk & Mar) to proceed. More importantly, we need better comparative cultural databases, the coding of which needs to be standardized, organized, and shared between researchers (Slingerland et al., 2020). To do that, we have started empirical

https://doi.org/10.1017/S0140525X21000923 Published online by Cambridge University Press

projects on imaginary worlds, and more generally on superstimuli in fictions. First, we are about to launch an experimental study to collect data from participants, including their movie preferences, measures of their psychological traits (such as their exploratory preferences [with the curiosity and exploration inventory; Kashdan et al., 2009], their Big Five personality traits, and their systemizing quotient) and their socio-demographic information. Second, we will very soon launch an online platform designed to collect and aggregate metadata about fictions (and specific content features) from around the world: the inventory of fictions. Hopefully, it will make it possible to empirically test specific predictions about the cultural evolution of fictions with standardized cross-cultural data, coming from experts of fictions worldwide. We are very grateful to all the commentators for their highly valuable contributions to the understandings of the cultural evolution and success of imaginary worlds which are, as virtually all commentators agreed upon, a fascinating content feature to study.

References

Anikina, O. V., & Yakimenko, E. V. (2015). Edutainment as a modern technology of education. *Procedia – Social and Behavioral Sciences*, *166*, 475–479. https://doi.org/10.1016/j.sbspro.2014.12.558.

Bakerjr, M., & Maner, J. (2008). Risk-taking as a situationally sensitive male mating strategy. *Evolution and Human Behavior*, *29*(6), 391–395. https://doi.org/10.1016/j.evolhumbehav.2008.06.001.

Banerjee, K., Haque, O. S., & Spelke, E. S. (2013). Melting lizards and crying mailboxes: Children's preferential recall of minimally counterintuitive concepts. *Cognitive Science*, *37*(7), 1251–1289. https://doi.org/10.1111/cogs.12037.

Barnes, J. L., Bernstein, E., & Bloom, P. (2015). Fact or fiction? Children's preferences for real versus make-believe stories. *Imagination, Cognition and Personality*, *34*(3), 243–258. https://doi.org/10.1177/0276236614568632.

Baron-Cohen, S. (2003). *The essential difference: The truth about the male and female brain*. Basic Books.

Baron-Cohen, S. (2006). The hyper-systemizing, assortative mating theory of autism. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, *30*(5), 865–872. https://doi.org/10.1016/j.pnpbp.2006.01.010.

Baron-Cohen, S. (2009). Autism: The empathizing-systemizing (E-S) theory. *Annals of the New York Academy of Sciences*, *1156*(1), 68–80. https://doi.org/10.1111/j.1749-6632.2009.04467.x.

Barrett, D. (2010). *Supernormal stimuli: How primal urges overran their evolutionary purpose* (1st ed). W.W. Norton & Co.

Baumard, N., & Chevallier, C. (2015). The nature and dynamics of world religions: A life-history approach. *Proceedings of the Royal Society B: Biological Sciences*, *282*(1818), 20151593. https://doi.org/10.1098/rspb.2015.1593.

Baumard, N., Huillery, E., & Zabro, L. (in press). The cultural evolution of love in history. *Nature Human Behaviour*.

Berlyne, D. E. (1950). Novelty and curiosity as determinants of exploratory behaviour. *British Journal of Psychology. General Section*, *41*(1–2), 68–80. https://doi.org/10.1111/j.2044-8295.1950.tb00262.x.

Bjorklund, D. F., & Pellegrini, A. D. (2000). Child development and evolutionary psychology. *Child Development*, *71*(6), 1687–1708. https://doi.org/10.1111/1467-8624.00258.

Black, J., & Barnes, J. L. (2015). Fiction and social cognition: The effect of viewing award-winning television dramas on theory of mind. *Psychology of Aesthetics, Creativity, and the Arts*, *9*(4), 423–429. https://doi.org/10.1037/aca0000031.

Bourdieu, P. (1979). *La distinction: Critique sociale du jugement*. Éditions de Minuit.

Boyer, P. (2001). *Religion explained: The evolutionary origins of religious thought*. Basic Books.

Boyer, P. (2020). Why divination?: Evolved psychology and strategic interaction in the production of truth. *Current Anthropology*, *61*(1), 100–123. https://doi.org/10.1086/706879.

Boyer, P., & Ramble, C. (2001). Cognitive templates for religious concepts: Cross-cultural evidence for recall of counter-intuitive representations. *Cognitive Science*, *25*, 535–564.

Castano, E. (2021). Art films foster theory of mind. *Humanities and Social Sciences Communications*, *8*(1), 119. https://doi.org/10.1057/s41599-021-00793-y.

Ciranka, S., & van den Bos, W. (2021). Adolescent risk-taking in the context of exploration and social influence. *Developmental Review*, *61*, 100979. https://doi.org/10.1016/j.dr.2021.100979.

Cosmides, L., & Tooby, J. (2013). Evolutionary psychology: New perspectives on cognition and motivation. *Annual Review of Psychology*, *64*(1), 201–229. https://doi.org/10.1146/annurev.psych.121208.131628.

Del Giudice, M., Angeleri, R., & Manera, V. (2009). The juvenile transition: A developmental switch point in human life history. *Developmental Review*, *29*(1), 1–31. https://doi.org/10.1016/j.dr.2008.09.001.

Dubey, R., & Griffiths, T. L. (2020). Reconciling novelty and complexity through a rational analysis of curiosity. *Psychological Review*, *127*(3), 455–476. https://doi.org/10.1037/rev0000175.

Dubey, R., Griffiths, T. L., & Lombrozo, T. (2020). If it's important, then I am curious: A value intervention to induce curiosity. *41st Annual Conference of the Cognitive Science Society*, 7.

Dubourg, E., André, J.-B., & Baumard, N. (2021a). L'origine des fictions: L'hypothèse des fonctions évolutionnaires sociales. *Fabula*, *25*.

Dubourg, E., André, J.-B., Baumard, N. (2021b). The evolution of music: One trait, many ultimate-level explanations. Commentary to 'origins of music in credible signaling' by Mehr et al. *Behavioral and Brain Sciences*, *44*, e98. https://doi.org/10.1017/S0140525X20001156.

Dubourg, E., & Baumard, N. (in press). Why and how did narrative fictions evolved? Fictions as entertainment technologies. *Frontiers in Psychology*.

Enquist, M., & Arak, A. (1994). Symmetry, beauty and evolution. *Nature*, *372*(6502), 169–172. https://doi.org/10.1038/372169a0.

Fitouchi, L., & Singh, M. (2021). *Supernatural punishment beliefs as manipulated explanations of misfortune* (preprint). PsyArXiv. https://doi.org/10.31234/osf.io/vejac.

FitzGibbon, L., Lau, J. K. L., & Murayama, K. (2020). The seductive lure of curiosity: Information as a motivationally salient reward. *Current Opinion in Behavioral Sciences*, *35*, 21–27. https://doi.org/10.1016/j.cobeha.2020.05.014.

Fletcher, G. J. O., Simpson, J. A., Campbell, L., & Overall, N. C. (2015). Pair-bonding, romantic love, and evolution: The curious case of *Homo sapiens*. *Perspectives on Psychological Science*, *10*(1), 20–36. https://doi.org/10.1177/1745691614561683.

Gangestad, S. W., & Kaplan, H. (2015). Life history theory and evolutionary psychology. In D. M. Buss & M. D. Giudice (Eds.), *The handbook of evolutionary psychology* (pp. 1–27). John Wiley & Sons, Inc. https://doi.org/10.1002/9781119125563.evpsych102.

Glocker, M. L., Langleben, D. D., Ruparel, K., Loughead, J. W., Gur, R. C., & Sachser, N. (2009a). Baby schema in infant faces induces cuteness perception and motivation for caretaking in adults. *Ethology*, *115*(3), 257–263. https://doi.org/10.1111/j.1439-0310.2008.01603.x.

Glocker, M. L., Langleben, D. D., Ruparel, K., Loughead, J. W., Valdez, J. N., Griffin, M. D., … Gur, R. C. (2009b). Baby schema modulates the brain reward system in nulliparous women. *Proceedings of the National Academy of Sciences*, *106*(22), 9115–9119. https://doi.org/10.1073/pnas.0811620106.

Gould, S. J. (2008). A biological homage to mickey mouse. *Ecotone*, *4*(1–2), 333–340. https://doi.org/10.1353/ect.2008.0045.

Greenberg, D. M., Warrier, V., Allison, C., & Baron-Cohen, S. (2018). Testing the empathizing–systemizing theory of sex differences and the extreme male brain theory of autism in half a million people. *Proceedings of the National Academy of Sciences*, *115*(48), 12152–12157. https://doi.org/10.1073/pnas.1811032115.

Haggard, P., & Chambon, V. (2012). Sense of agency. *Current Biology*, *22*(10), R390–R392. https://doi.org/10.1016/j.cub.2012.02.040.

Hamilton, W. D. (1964). The genetical evolution of social behaviour. I. *Journal of Theoretical Biology*, *7*(1), 1–16. https://doi.org/10.1016/0022-5193(64)90038-4.

Hill, K. (1993). Life history theory and evolutionary anthropology. *Evolutionary Anthropology: Issues, News, and Reviews*, *2*(3), 78–88. https://doi.org/10.1002/evan.1360020303.

Hinde, R. A., & Barden, L. A. (1985). The evolution of the teddy bear. *Animal Behaviour*, *33*(4), 1371–1373. https://doi.org/10.1016/S0003-3472(85)80205-0.

Kaestle, C. F. (1985). The history of literacy and the history of readers. *Review of Research in Education*, *43*, 11–53.

Kaplan, H. S., & Gangestad, S. W. (2005). Life history theory and evolutionary psychology. In D. M. Buss (Ed.), *The handbook of evolutionary psychology* (pp. 68–95). John Wiley & Sons, Inc.

Kashdan, T. B., Gallagher, M. W., Silvia, P. J., Winterstein, B. P., Breen, W. E., Terhar, D., & Steger, M. F. (2009). The curiosity and exploration inventory-II: Development, factor structure, and psychometrics. *Journal of Research in Personality*, *43*(6), 987–998. https://doi.org/10.1016/j.jrp.2009.04.011.

Kidd, D. C., & Castano, E. (2013). Reading literary fiction improves theory of mind. *Science (New York, N.Y.)*, *342*(6156), 377–380. https://doi.org/10.1126/science.1239918.

Krebs, J. R., & Dawkins, R. (1978). Animal signals: Mind reading and manipulation. In *Behavioral ecology: An evolutionary approach* (pp. 380–402). Blackwell Scientific Publications.

Ling, J., Burton, T. C., Salt, J. L., & Muncer, S. J. (2009). Psychometric analysis of the systemizing quotient (SQ) scale. *British Journal of Psychology*, *100*(3), 539–552. https://doi.org/10.1348/000712608X368261.

Litman, J. (2005). Curiosity and the pleasures of learning: Wanting and liking new information. *Cognition & Emotion*, *19*(6), 793–814. https://doi.org/10.1080/02699930541000101.

Lorenz, K. Z. (1966). Evolution of ritualization in the biological and cultural spheres. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *251*(772), 273–284.

Mehr, S. A., Krasnow, M., Bryant, G. A., & Hagen, E. H. (2020). *Origins of music in credible signaling* (preprint). PsyArXiv. https://doi.org/10.31234/osf.io/nrqb3.

Morin, O., Acerbi, A., & Sobchuk, O. (2019). Why people die in novels: Testing the ordeal simulation hypothesis. *Palgrave Communications*, *5*(1), 62. https://doi.org/10.1057/s41599-019-0267-0.

Nettle, D. (2005a). The wheel of fire and the mating game: Explaining the origins of tragedy and comedy. *Journal of Cultural and Evolutionary Psychology*, *3*(1), 39–56. https://doi.org/10.1556/JCEP.3.2005.1.3.

Nettle, D. (2005b). Exploring the psychological foundations of drama. In J. Gottschall & D. S. Wilson (Eds.), *The literary animal: Evolution and the nature of narrative* (pp. 56–75). Northwestern University Press. https://doi.org/10.2307/j.ctvw1d5h1.

Norenzayan, A., Atran, S., Faulkner, J., & Schaller, M. (2006). Memory and mystery: The cultural selection of minimally counterintuitive narratives. *Cognitive Science*, *30*(3), 531–553. https://doi.org/10.1207/s15516709cog0000_68.

Nyhout, A., & O'Neill, D. K. (2017). Children's enactment of characters' movements: A novel measure of spatial situation model representations and indicator of comprehension. *Mind, Brain, and Education*, *11*(3), 112–120.

Panero, M. E., Weisberg, D. S., Black, J., Goldstein, T. R., Barnes, J. L., Brownell, H., & Winner, E. (2016). Does reading a single passage of literary fiction really improve theory of mind? An attempt at replication. *Journal of Personality and Social Psychology*, *111*(5), e46–e54. https://doi.org/10.1037/pspa0000064.

Ryan, M. J., Fox, J. H., Wilczynski, W., & Rand, A. S. (1990). Sexual selection for sensory exploitation in the frog *Physalaemus pustulosus*. *Nature*, *343*(6253), 66–67. https://doi.org/10.1038/343066a0.

Scalise Sugiyama, M. (2011). The forager oral tradition and the evolution of prolonged juvenility. *Frontiers in Psychology*, *2*. https://doi.org/10.3389/fpsyg.2011.00133.

Schofield, R. S. (1973). Dimensions of illiteracy, 1750–1850. *Explorations in Economic History*, *10*(4), 437–454. https://doi.org/10.1016/0014-4983(73)90026-0.

Scrivner, C., Johnson, J. A., Kjeldgaard-Christiansen, J., & Clasen, M. (2021). Pandemic practice: Horror fans and morbidly curious individuals are more psychologically resilient during the COVID-19 pandemic. *Personality and Individual Differences*, *168*, 110397. https://doi.org/10.1016/j.paid.2020.110397.

Singh, M. (2018). The cultural evolution of shamanism. *Behavioral and Brain Sciences*, *41*, e66. https://doi.org/10.1017/S0140525X17001893.

Singh, M. (2020). *Subjective selection and the evolution of complex culture*. 21.

Singh, M. (2021). The sympathetic plot, its psychological origins, and implications for the evolution of fiction. *Emotion Review*, *13*(3), 16.

Singhal, A. (Ed.) (2004). *Entertainment-education and social change: History, research, and practice*. Lawrence Erlbaum Associates.

Slingerland, E., Atkinson, Q. D., Ember, C. R., Sheehan, O., Muthukrishna, M., Bulbulia, J., & Gray, R. D. (2020). Coding culture: Challenges and recommendations for comparative cultural databases. *Evolutionary Human Sciences*, *2*, e29. https://doi.org/10.1017/ehs.2020.30.

Sperber, D., & Hirschfeld, L. A. (2004). The cognitive foundations of cultural stability and diversity. *Trends in Cognitive Sciences*, *8*(1), 40–46. https://doi.org/10.1016/j.tics.2003.11.002.

Spitzer, M., & Kiesel, A. (2021). *Curiosity as a Function of Confidence and Importance in Knowing Information* (preprint). PsyArXiv. https://doi.org/10.31234/osf.io/dzanq.

Steinberg, L., Icenogle, G., Shulman, E. P., Breiner, K., Chein, J., Bacchini, D., … Takash, H. M. S. (2018). Around the world, adolescence is a time of heightened sensation seeking and immature self-regulation. *Developmental Science*, *21*(2), e12532. https://doi.org/10.1111/desc.12532.

Stojic, H., Analytis, P. P., Schulz, E., & Speekenbrink, M. (2020). *It's new, but is it good? How generalization and uncertainty guide the exploration of novel options*. 35.

Stone, L. (1969). Literacy and education in England 1640–1900. *Past and Present*, *42*(1), 69–139. https://doi.org/10.1093/past/42.1.69.

Stubbersfield, J., & Tehrani, J. (2013). Expect the unexpected? Testing for minimally counterintuitive (MCI) bias in the transmission of contemporary legends: A computational phylogenetic approach. *Social Science Computer Review*, *31*(1), 90–102. https://doi.org/10.1177/0894439312453567.

Sugiyama, M. S. (2021). The fiction that fiction is fiction. *ASEBL Journal*, *15*, 8–12.

Sugiyama, S. (2005). Reverse-engineering narrative. In J. Gottschall & D. S. Wilson (Eds.), *The literary animal*. (pp. 177–196) Northwestern University Press.

Taggart, J., Heise, M. J., & Lillard, A. S. (2018). The real thing: Preschoolers prefer actual activities to pretend ones. *Developmental Science*, *21*(3), e12582. https://doi.org/10.1111/desc.12582.

Tinbergen, N. (1969). *The study of instinct* (1st ed. 2nd impression). Clarendon P.

Veale, J. F., & Williams, M. N. (2017). The psychometric properties of a brief version of the systemizing quotient. *European Journal of Psychological Assessment*, *33*(3), 173–180. https://doi.org/10.1027/1015-5759/a000283.

Veblen, T. (1899). *Theory of the leisure class* (New ed). Macmillan.

Verpooten, J., & Nelissen, M. (2010). Sensory exploitation and cultural transmission: The late emergence of iconic representations in human evolution. *Theory in Biosciences*, *129*(2–3), 211–221. https://doi.org/10.1007/s12064-010-0095-7.

Wade, S., & Kidd, C. (2019). The role of prior knowledge and curiosity in learning. *Psychonomic Bulletin & Review*, *26*(4), 1377–1387. https://doi.org/10.3758/s13423-019-01598-6.

Wakabayashi, A., Baron-Cohen, S., Wheelwright, S., Goldenfeld, N., Delaney, J., Fine, D., … Weil, L. (2006). Development of short forms of the empathy quotient (EQ-short) and the systemizing quotient (SQ-short). *Personality and Individual Differences*, *41*(5), 929–940. https://doi.org/10.1016/j.paid.2006.03.017.

Zunshine, L. (2006). *Why we read fiction: Theory of mind and the novel*. Ohio State University Press.