

# **Why Designer's Intended Function is Central for Proper Function Assignment and Artifact Conceptualization: Essentialist and Normative**

## **Accounts**

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## **Abstract**

People tend to think that the function intended by an artifact's designer is its real or proper function. Relatedly, people tend to classify artifacts according to their designer's intended function (DIF), as opposed to an alternative opportunistic function. This centrality of DIF has been shown in children from 6 years of age and in adults, and it is not restricted to western societies. We review four different explanations for the centrality of DIF, integrating developmental and adult data. Two of these explanations are essentialist accounts (causal and intentional essentialism). Two of them are normative accounts (conventional function and idea ownership). Though essentialist accounts have been very influential, we review evidence that shows their limitations. Normative accounts have been less predominant. We review evidence to support them, and discuss how they account for the data. In particular, we review evidence suggesting that the centrality of DIF can be explained as a case of idea ownership. This theory makes sense of a great deal of the existing data on the subject, reconciles contradictory results, links this line of work to other literatures, and offers an account of the observed developmental trend.

**Keywords:** artifacts; function; design; essentialism; ownership

## Introduction

If you look at your surroundings right now, most things that you see are probably artifacts created by people to fulfill different functions. Chairs, pens, lightbulbs, computers, are part of an artificial environment that humans have created for themselves. To participate in a culture, people need to acquire the functions of its artifacts. There are some very simple functions (e.g., containment) that are acquired early in development (e.g., Aguiar & Baillargeon, 1998; Caron, Caron, & Antell, 1988). However, most functions need prolonged periods to be learned. As we shall see, the adult pattern of performance does not appear until 6 years-of-age.

A central aspect of learning an artifact's function is understanding that though it may have many different functions depending on what it is used for (e.g., a hammer may be used to hold loose sheets of paper in place), there is one function that is proper to it (i.e., a hammer's proper function is to pound nails in place), which generally corresponds to what the object was originally designed for. In what follows, we will review evidence that the designer's intended function (DIF) is an important factor in the assignment of proper function and in artifact categorization, that the relevance of this factor develops from early childhood into adulthood, and that it generalizes across cultures. Then, in the subsequent sections, and after having described the phenomenon, we will critically discuss two kinds of explanations for it: essentialist and normative accounts. In Fig. 1, the reader may find a summary of the theoretical alternatives we will discuss, their main claims, and references to representative relevant work that supports each theory.

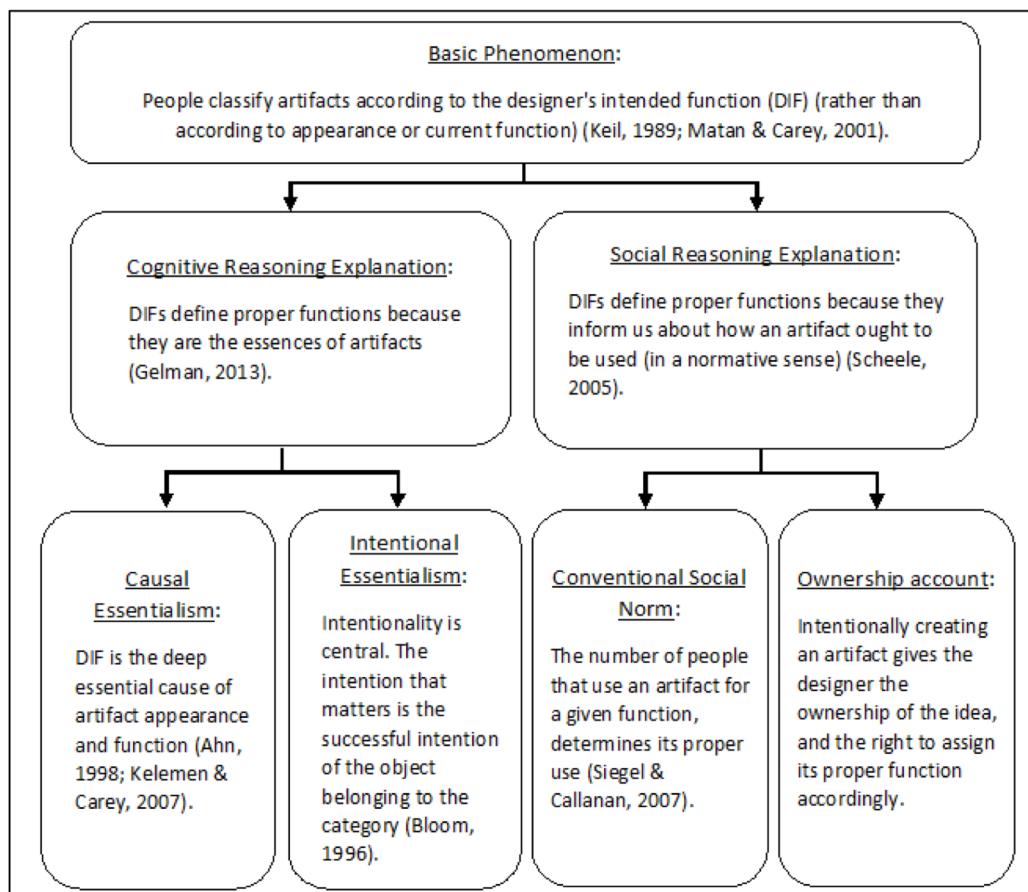


Figure 1. Main competing theories, along with relevant references discussed in the current work. Note that the Ownership account does not have associated references because though the cognitive bases of ownership judgments have been investigated, there is no direct evidence for its role regarding the assignment of proper function.

Function is a complex relational property which coherently organizes information from different conceptual domains (Barsalou, Sloman, & Chaigneau, 2005). An extended view among researchers is that understanding function requires conceptually representing an event where an intentional agent uses the functional object to achieve a goal, revealing the object's physical properties that are causally relevant for the attainment of that goal (Futó, Téglás, Csibra, & Gergely, 2010). When subjects are allowed to understand it, artifact function becomes a central conceptual property, focuses attention to an object's functionally relevant physical properties, and guides categorization and artifact naming

from early in development (reviewed in Chaigneau & Barsalou, 2008). In fact, evidence suggests that function can guide conceptualization from as early as 10 months of age (Futó, Téglás, Csibra, & Gergely, 2010).

As development proceeds, conceptual information about function acquires an increasingly complex structure. By 6 years-of-age, children already understand that though an artifact may afford different uses, it has a function that is proper to it, which generally coincides with the object's designer's intended function (i.e., what the artifact was made for) (see, e.g., Defeyter, Avons, & German, 2007). This tendency to conceptualize artifacts according to their designer's intended function (DIF), as opposed to other sources of information, is a stable and well documented phenomenon (see Fig. 1). Though the experimental paradigm that provides most of the evidence mirrors procedures used by Matan and Carey (2001), the phenomenon was first shown by Lance Rips (1989). In his experiment, Rips described the design of an object with a given function (e.g., a lampshade), but with the object resembling a different category (e.g., an umbrella). Participants were asked to provide categorization, typicality and similarity ratings. Results showed that though subjects recognized the low typicality of the artifact and the low resemblance to other members of its intended category, they still classified it according to its designer's intended function (e.g., participants thought the artifact was a lampshade, though it was atypical and more similar to an umbrella than to other lampshades).

In the affordances view of artifact function, an artifact is thought to be categorized according to its current function (i.e., the outcome that is achieved when using an artifact, depending on the interaction between its physical structure and an agent's intentional actions). Researchers have shown that adults attend to affordance information and use it centrally in categorization (Chaigneau, Barsalou, & Sloman, 2004; Puebla & Chaigneau,

2014). Similar results have been obtained with young children (Kemler-Nelson, Frankenfield, Morris, & Blair, 2000; Kemler-Nelson, Russell, et al., 2000; Madole & Oakes, 2005; Smith, 1999). Thus, an interesting issue has been whether DIF can override current function. In fact, Matan and Carey (2001) presented subjects (adults and young children) with stories about objects designed by a character for something (e.g., for watering plants) and later used by another character for something else (e.g., for making tea). Results showed that 6-year-olds and adults (but not 4-year-olds) tended to classify objects consistently with the artifact's DIF (a watering can), and not according to current use (a teapot).

A crucial aspect of the DIF's effect is that the design needs to be intentional. Gelman and Bloom (2000) explored this issue by describing objects (e.g., a newspaper) that were accidentally or intentionally transformed into an artifact (e.g., a paper hat). Adults, 5-year-olds, and even 3-year-olds chose a name (e.g., hat) rather than referring to the material (e.g., paper) to describe the object when it was intentionally created, but showed the reverse pattern when the object was accidentally created. Furthermore, there is evidence that not just any intention produces the aforementioned bias. People believe that only a designer's intended function deserves to be the artifact's proper function. In Chaigneau, Castillo and Martínez (2008, Exp. 3), adults read scenarios where an artifact was designed for function X but later used for function Y. When function Y was implemented by an opportunistic user (different from the designer), participants tended to judge that function X was the artifact's proper function. In contrast, when the designer himself implemented the alternative function Y, the bias towards the designer's original function X became undetectable. Apparently, it is the designer who has the right to assign proper function,

provided that the designer created the artifact intentionally. We will return to this issue later.

Finally, the pattern of results described above seems to generalize across different cultures. Barrett, Laurence and Margolis (2008) presented their subjects (members of the Shuar Amazonian tribe) with the same type of scenarios used by Matan and Carey (2001). The rationale for testing these materials with members of the Shuar group, is that their culture was relatively sparse in technological artifacts. Most of their artifacts were simple, not mass produced, and feasible to be created by a single person. If being exposed to artifacts and technology were the basis for the designer's intended function bias, then the effect should have not been observed among the Shuar. Contrary to this expectation, the Shuar did show a strong preference to assign function according to the DIF rather than by current use (see also German & Barrett, 2005). These results support the idea that the preference for the designer's intended function is in some sense basic and general, and not the result of being exposed to numerous artifact categories.

### **Essentialist accounts of the preference for the designer's intended function**

The preference for the DIF when assigning function and categorizing artifacts, is considered by some as evidence of essentialism (e.g., Keil, 1989; Rips, 1989). Basically, an artifact's history is its essence because it is the deep central cause that explains its physical appearance and its function (Gelman, 2013). Purportedly, whereas natural kinds conform to a common cause model in which internal properties like DNA cause many other observable properties such as appearance and behavior (Gelman, 2003), for artifacts the DIF is the root cause of many other artifact properties like its physical structure and function (Ahn, 1998;

Ahn, Kalish, Gelman, et al., 2001; Kemler-Nelson, Frankenfield, Morris, & Blair, 2000; Kelemen & Carey, 2007). In this account, the preference for the DIF would be a case of causal knowledge affecting classification (we will return to this point later).

A different version of an essentialist account is offered by Bloom (1996) (see Fig. 1). He argues that DIF is not specific enough to select a category's correct extension (i.e., to select all correct category exemplars, while leaving out exemplars from related categories). Take for example the intention of something being used to sit on. This intention would not differentiate chairs from stools. Hence, the DIF cannot be what determines category membership. For Bloom, the intention that matters is the successful intention of the object belonging to the category. Thus, e.g., broken artifacts would remain members of their categories because, though broken artifacts cannot perform their functions anymore, their designer intended them to be category members (Gutheil, Bloom, Valderrama, & Freedman, 2004).

Though causal essentialism and Bloom's intentional essentialism do make some contrasting predictions (e.g., about the classification of broken objects), they both argue that artifacts are not conceptualized by observable properties (physical structure, current function) but by the intentions of the designer. Therefore, designers' intentions should show their conceptual centrality even if a different experimental paradigm were used (i.e., different from directly pitting the designer's intended function against another kind of information, and asking participants to choose between the two, as in the Matan and Carey paradigm).

In fact, a different paradigm was used in Puebla and Chaigneau (2014) and different results were obtained. In four experiments, participants were presented with scenarios describing novel artifacts, and were asked to categorize them (using a 7-point rating scale).



Each participant received and categorized several scenarios that offered all possible combinations of 5 properties (DIF, physical structure, user intention, user action and functional outcome), which could be in intact or compromised states. Contrary to what is predicted by essentialist and intentional theories, intentional design was never more important for classification than the artifact's functional outcome (i.e., its current function). Though the DIF was always correlated with categorization ratings, it did not behave as an essence (for similar results, see also Chaigneau, Barsalou, & Sloman, 2004).

Hampton, Storms, Simmons and Heussen (2009) used a similar procedure. In the Hampton et al. study, participants were presented with artifacts described by all possible combinations of design function, current function and appearance, and asked to categorize them (a dichotomous "yes" or "no" answer). Depending on the descriptions, artifacts could be classified in categories A or B (e.g., an object described as "originally intended and used to provide transport for small groups of people to their desired destination" was more probable to be classified as a taxi, and an object described as "originally intended and used to carry sick or injured people to hospital for urgent medical attention" was more probable to be classified as an ambulance). To gauge the influence of each property, data were analyzed by computing a probability of answering "yes" depending on the state of the property type. Though this was not the focus in Hampton et al., their data showed (computed by us from Hampton et al., 2009, Table 1) that the probability of classifying the object as a member of the category was greater if the current function coincided with the category (all other factors controlled for,  $p = .79$ ) than if the design function coincided ( $p = .63$ ). Furthermore, the negative effect of having an incorrect or inconsistent property (i.e., the effect of having the property of the alternative category), was greater for the current

function ( $p$  decreased from .79 to .22) than for the design function ( $p$  decreased from .63 to .39).

Additionally, both above cited studies (Hampton et al., 2009; Puebla & Chaigneau, 2014) found that the DIF was not part of people's artifact causal model. In causal essentialism, the centrality of the DIF derives from its centrality in an artifact's causal model. It is assumed that DIF is conceived as the deep cause of the artifact's physical structure and function. Puebla and Chaigneau (2014) tested this assumption by using scenarios where one or more properties could be in three different states: intact, compromised or absent (i.e., with no information about that property). If the DIF plays a causal role, it should have allowed participants to infer the state of missing information (e.g., using the DIF to infer the state of the artifact's physical structure, or of the state of the functional outcome), which would lead to an increase in its importance when other properties are absent relative to when they are present. Contrary to that hypothesis, the DIF was not used for making inferences about the state of missing information. In contrast, artifact's physical structure was used to make inferences about functional outcome (i.e., artifact's physical structure had a greater effect when the state of functional outcome was missing in comparison with when it was known, whether it was intact or compromised).

Relatedly, if people conceive the DIF as the cause of other artifact properties (e.g., physical structure), then DIF should cohere with those other properties (Rehder & Kim, 2010). Coherence means that properties that are causally related (i.e.,  $A \rightarrow B$ ), provide more evidence for classifying category instances when both properties appear together in an exemplar (i.e., A and B) than would be expected from the separate contribution of each individual property (i.e., there should be a nonlinear effect of A and B on ratings). Puebla

and Chaigneau (2014) and Hampton et al. (2009) tested for coherence in artifact concepts and found it, but not for the DIF.

To summarize the evidence discussed to this point: The preference for the DIF occurs across age groups (from 6-year-olds to adulthood) and cultures. The evidence for it is obtained when the designer's intentional function is directly pitted against an alternative but current function. Because the designer's intention is critical, when the designer imagines a new function for an artifact, the preference for the original function is lost. Problematically, the predictions of causal and intentional essentialism do not generalize well to other paradigms. When a different experimental paradigm is used, where several properties are systematically manipulated (e.g., appearance, current function, DIF), though the DIF remains relevant for categorization, it loses centrality against current function and does not show evidence of being an essence. It is not the most central artifact property, and it does not relate causally with other artifact properties.

### **Normative accounts of the preference for designer's intended function**

Essentialist theories are not the only way to explain the DIF's relevance for proper function. Artifacts are objects created and used in social contexts, so it is possible that people reason normatively about artifacts' functions. In this view, rather than answering the question about what is an artifact's proper function by, e.g., inferring what it is most efficient for, people may ask themselves what they know about the norms for its use (Scheele, 2005) (see Fig. 1). Though norms have been studied in social sciences in general, we believe that an approach used in philosophy is pertinent here. In philosophy, social norms are frequently seen as solutions to social coordination problems, in particular when there are no objective criteria to choose one particular solution over another (Lewis, 1969).

A classic example is driving on the right or left side of the road. In this view, the expectation that other people will conform to the norm is an integral part of the understanding of the norm (e.g., we drive on the right or left side of the road because we expect that others will do the same, and would protest if done otherwise). In this normative account, people give greater conceptual weight to DIFs, because they expect that artifacts will be used for whatever they were designed for, rather than for an alternative possible function. Note that this sense of “normative” is not the same as may be found in discussions of generic statements. In Prasada's (2000) discussion of the topic, generic knowledge is assumed to provide a mechanism that explains why certain properties are necessary for category items, and in this sense, generics are essential properties. Of course, an artifact's DIF is generic in this sense (i.e., unlike natural kinds, artifacts need to be intentionally designed and manufactured by someone). However, many other artifact properties may be generic in this sense (e.g., that table has a flat surface is also a generic statement, and essential in Prasada's sense, because a flat surface enables a user to put things on it). Therefore, generic knowledge is not specific enough to account for why DIFs are viewed in some tasks as conceptually more relevant than other artifact properties that may also be generic.

There is evidence of the normative value (in the social sense) of artifact function. For example, Casler et al. (2009), have shown that 2- and 3- year-olds exhibit more normative responses (e.g., protesting) when a puppet uses artifacts in atypical ways than when the puppet uses the artifacts for their standard functions; this result holds even when the artifacts are new and the standard functions are demonstrated just before the atypical use by the puppet. We next review two theories that offer norm-based explanations of the DIF's relevance for proper function.

The first norm-based explanation states that the DIF is important simply because it's a reliable cue to the way in which an artifact is typically used by other people (for expository purposes, let's call this the conventionality hypothesis). Now, it turns out that one can directly tell someone that an artifact is conventionally used for something (i.e., telling them that many people use it in a specific way). Hence, if the DIF derives its centrality from informing us about what we can normatively expect about other people's behavior (i.e., that most people use the artifact for the DIF), receiving opposed information about its conventional use should reduce or even cancel out the DIF's effects. In other words, when an artifact's DIF and conventional function are pitted against each other, people should show no preference regarding which is its proper function (Siegel & Callanan, 2007).

To date, the few studies that pitted conventionality against the DIF have obtained mixed results. However, when put all together they show an interesting developmental trajectory. Siegel and Callanan (2007) have shown that when confronted with a decision between a design function and a current conventional function (e.g., an artifact designed for trapping bugs but now used by many people to collect raindrops), 5- year-olds, 7-year-olds reduced their preference for the DIF relative to when the current function was implemented by a single individual (idiosyncratic function). This apparently favors the normative account. More recently, however, Defeyter et al. (2009) offered a more nuanced view. They reported that when asked to judge function (i.e., "What is it really for?"), 4- and 6-year-olds had no preference between a design function and a current function, either when the current function was idiosyncratic or conventional (i.e., they found that any intentional use could be proper function). However, when asked to make category membership judgments of the same objects (i.e., "What is it really?"), 4- and 6-year-olds responded according to the design

function when the current use was idiosyncratic, but showed no preference when the current use was conventional (in line with Siegel & Callanan, 2007). Notably, adults preferred the DIF in both questions. Thus, these studies suggest that for adults the DIF but not the social convention is considered relevant for proper function (contrary to the conventionality account). However, the pattern of function judgments suggest that, at least until age 6, children consider any intentional use, be it the DIF, the conventional function or a current function, as relevant to determine the proper function of an artifact (and for categorization judgments only the DIF and the conventional function seem to be relevant).

Other studies have sought to compare the relevance of the DIF and social conventions for proper function without pitting one against the other. For example, Chaigneau and Puebla (2013) presented adult participants with a story about an artifact. The artifact had two possible functions (X or Y), both equally plausible. Participants learned that the object had been created for function X (or Y), was used by all people for function X (or Y) and was idiosyncratically used by an individual for function X (or Y). Critically, participants also learned that the individual had an accident when using the artifact for the chosen current function, whichever it was. Subjects' task was to rate the artifact's efficiency for the current function, its proper function (i.e., whether it was the current or the alternative function), and its use (i.e., whether the individual's current use of the artifact was correct or not). The combination of X and Y functions produced the experiment's 4 conditions: normative function (when DIF, convention and current use all agreed; either all X or all Y), historical function (when DIF and current use agreed, but convention did not), conventional function (when convention and current use agreed, but DIF did not), and idiosyncratic use (when DIF and convention agreed, but current use did not). As would be expected, results showed that the function involved in the accident was

perceived as less efficient than the alternative function, tended not to be considered the artifact's proper function, and was thought not to be a correct use for the artifact. However, and importantly, this pattern of reduced ratings held only when the current function was idiosyncratic or when it was conventional. Information about social conventions was unable to allow the stable assignment of proper function, behaving more like an idiosyncratic use than as a social norm. In contrast, DIFs allowed for stable assignment of proper function, even in the face of contradictory information.

Puebla (2015) adapted the same experimental paradigm to be used with children, and found evidence consistent with a transition to the adult pattern described above. He presented 4-to-5 and 6-to-8 year-olds with stories about an artifact with two equally plausible functions. One of them was presented as either the artifact's conventional function or its DIF, while the alternate function was presented as a different, possible use. A character subsequently attempted to use the artifact to bring about a target outcome (the conventional function or the DIF), which resulted in either success or artifact malfunction. Children were asked to identify the artifact's 'real' function. In the case of malfunction, in both age groups children's choices were at chance. This contrasted with a baseline condition where no information about conventionality or design was given and children avoided the malfunctioning alternative. Unlike in Chaigneau and Puebla (2013), Puebla (2015) found that for children both DIF and convention were informative about proper function. However, when the attempt succeeded, 4-to-5 years-olds preferred conventional functions to the alternative and 6-to-8 years-olds preferred conventional function and DIF to the alternative. Thus, it appears that conventionality started to influence function judgments earlier than DIFs.

A social influence study by Seston and Kelemen (2014, study 2) also shows that social conventions have an earlier influence in children's artifact function judgments. In this study 3- and 4-year-olds watched a video in which two informants showed an overt consensus on the function of a novel artifact while disagreed with a lone dissenter. The function supported by the majority was either as plausible as the function supported by the dissenter (weak trials), or implausible while the minority function was plausible (strong trials). Children's task was to state what they thought the object was for. In the weak trials, 3-year-olds preferred the majority function (i.e., conventional) while the 4-year-olds' answers were at chance. However, in the strong trials the 4-year-olds eschewed the functions supported by the majority while the 3-year-olds showed no preference. Thus, this study suggests that social conventions are progressively less important to determine the functions of tools with age and that to have an effect on function judgments these conventions have to be plausible in light of an artifact's physical properties.

All these studies on social conventions and function can be integrated in a developmental trajectory. When confronted with a decision between the DIF and a current conventional function, adults prefer the DIF and young children show no preference. For adults and older children, DIF—and not convention—determines proper function. Studies comparing the influence of these variables without pitting one against the other also show that adult function judgments follow the DIF but not the social convention, while younger children seem to consider both of these variables as relevant for proper function (with the effect of conventionality emerging earlier than the DIF). Furthermore, this pattern of results is consistent with social influence research showing that conventionality become less important for function judgments with age. Thus, the results presented to this point suggest that the straightforward conventionality hypothesis does not fit the available data



satisfactorily. The conventionality account could explain the younger children's pattern of judgments, but not the adults' pattern. There appears to be a developmental transition from an initial stage when conventionality and DIF seem to constitute effective cues to an artifact's proper function (with conventionality showing an earlier influence) to a mature stage where only DIF seems to be relevant for proper function. A different factor other than conventionality must account for the DIF's centrality in adult function assignment and classification.

Another kind of normative explanation is the following (see Fig. 1, "Ownership account"). Though it is not a previously published explanation for the DIF's relevance in artifact categorization, we believe there is abundant and convincing evidence for its relevance to the topic, and that researchers interested on artifact conceptualization across development may have overlooked it or its significance. In this view, asking people to choose between the function intended by the object's designer and an alternative opportunistic function (i.e., the Matan and Carey experimental paradigm) is tantamount to asking participants to decide who has the right to assign function (the designer or the opportunistic user). In the current work, we will refer to this as the ownership account of proper function. If people think of this as a decision about ownership, they may believe that a designer owns the idea of the object's function by virtue of having intentionally created the artifact category, and that assigning function to the artifact category is a relevant right in this domain. Note that, because we know that function is a central property that guides categorization (Chaigneau & Barsalou, 2008; Chaigneau, Barsalou & Sloman, 2004), the way in which people assign function determines their classification decisions too (but see Defeyter et al., 2009).

Adults and children do in fact reason about the ownership of objects and ideas. The understanding that objects can be owned (as opposed to simply being possessed) develops early in life. By 2 years of age, children understand that certain familiar objects are owned by them or close relatives (Fasig, 2000). Also by 2 years of age, children use the first possession heuristic to decide who owns an object (i.e., whoever first possesses an object is judged to be the owner; Friedman & Neary, 2008). Additionally, by 3 years of age, children understand that object ownership grants certain rights. In particular, that the owner of an object decides whether or not others can use it (called “control and permission”; Neary, Friedman, & Burnstein, 2009). Also by 3 years of age, children understand that those rights are normative and should not be violated, as signaled by protesting when an object that belongs to a third party is thrown away by someone else (Rossano, Rakoczy, & Tomasello, 2011).

The adult pattern of judgments regarding object ownership adds some elements that are important for the argument we develop here. Adults judge that an object may be owned if the putative owner intentionally worked to attain the object (Palamar, Le, & Friedman, 2012). In particular, if someone intentionally creates an object, he or she may be granted ownership of the object (as when works of art are created; Levene, Starmans, & Friedman, 2015).

In contrast to object ownership, knowledge that ideas can be owned develops later. However, both kinds of judgments bear remarkable similarities. In four experiments, Shaw, Li and Olson (2012) showed that adults and children use the first possession heuristic to assign ownership to ideas, and that they also associate the ownership of ideas with control and permission (i.e., the owner of an idea can control other people's use of it). Furthermore, just as happens with objects, stealing does not confer ownership of ideas. Olson and Shaw

(2011) provided evidence that by 6 years of age, children showed dislike for characters that plagiarized art drawings, but that 4-year-olds did not.

Despite the similarities between ownership of objects and ideas, there is one important difference that needs to be highlighted. In the case of objects, that which is owned is an individual instance. If you own a car, it is that specific car which is yours. You have no rights over other cars of the same make, year, model, etc. In the case of ideas, in contrast, that which is owned is the whole class of possible instantiations of the idea. If this were not the case, then plagiarizing would not be problematic. Thus, an idea determines a class of entities (i.e., those that instantiate the idea), and not only an individual entity.

To summarize, the ownership of objects and ideas can be inferred by children and adults using similar heuristics, and children understand that ownership grants certain rights that should be respected. By now, the parallels between research on ownership and research on DIF should be apparent. It is likely that designing an artifact with the intention that it fulfills a function that defines a category, grants the designer ownership of the idea. Therefore, under normal conditions, the designer controls the artifact's proper function, just as happens with the ownership of ideas. Note here that, as we already highlighted, owning the idea of an artifact (and its function) implies all instantiations of the same idea, and not only a specific object with a certain function.

The ownership account of proper function fares well against the evidence discussed in the "Introduction" and "Essentialist accounts" sections. Research on ownership shows that intention and labor grant ownership. This is straightforwardly consistent with evidence showing that the DIF is judged to be the proper function, and that an alternative opportunistic function tends not to be, because the designer works on the creation of an artifact, whereas an opportunistic user does not. It is also consistent with results showing

that accidental creation (i.e., where intention is lacking) does not lead people to judge that an artifact has been created. Furthermore, if intentionality is part of what grants the designer the right to assign function, he or she should have the right to assign a new function. Consistently, recall that in Chaigneau et al. (2008), the preference for the DIF was reduced to non-significance when the designer herself intentionally assigned a new function. Research on ownership also shows that rights over an idea depend on being the first to arrive at the idea (i.e., first possession). Certainly, designers also meet this criterion for ownership.

Turning now to the contradictory evidence discussed in the “Essentialist accounts” section, recall that essentialist accounts of the centrality of the DIF run into difficulties when a different experimental paradigm is used. When current function and DIF are directly pitted against each other, DIF appears to be essential. When DIF and current function are presented among other sources of functional information, DIF loses centrality and does not behave like an essence (current function is more central). The ownership account of proper function could explain contradictory evidence as a consequence of differences in task demands. In the Matan and Carey (2001) paradigm, participants are forced to choose between a function assigned by someone who has acquired the right to assign function, and someone who has not. This demand is lessened in studies that use a different paradigm that does not pit designer and current use directly against each other. Additionally, because the ownership explanation for the DIF's preference is normative and not causal, the ownership account is consistent with the DIF being only weakly causally related to other artifact properties (Hampton et al., 2009; Puebla & Chaigneau, 2014). In fact, there is evidence that the DIF can exert its effect on function assignment independently from causal judgments. In Chaigneau et al. (2008, Experiments 1 and 2),

causal information relating artifact structure and function was carefully controlled such that two functions for the same artifact were equally efficient (Experiment 1) or perceptibly different (i.e., one more efficient than the other; Experiment 2). On both experiments, information about the DIF swayed participants' assignment of function. In Experiment 1, despite about equal efficiency, subjects assigned function according to the DIF. In Experiment 2, participants assigned function according to the DIF even when the historical function was perceptibly less efficient than the alternative function.

The ownership account is also consistent with other experimental results that present a challenge for essentialist theories. Several studies suggest that the preference for the DIF is a relatively late development that occurs into a child's sixth year of life (Defeyter & German, 2003; Diesendruck, Markson, & Bloom, 2003; German & Johnson, 2002; Matan & Carey, 2001). At earlier ages, children are able to understand objects' affordances (e.g., Madole & Cohen, 1995) and may use adult's intentional actions to assign function (Casler & Kelemen, 2005), but are not inclined to assign function based on design (as discussed in the "Essentialist accounts" section). This development is often explained as a conceptual change having to do with an understanding of the causal relation between design and function (e.g., Ahn, Kalish, Gelman, et al., 2001; Matan & Carey, 2001). Notably, the only experiment we know of which offers a direct test of this idea, questions it. Kelemen, Seston and Saint Georges (Exp. 1, 2012) tested children (3- and 4-year-olds) and adults by presenting them with pairs of objects that shared a common function (e.g., to crush popcorn). One of the objects had physical features that were optimal for accomplishing the function (e.g., a cylindrical block with an even base), while the other artifact was suboptimal (e.g., a similar object with ridges in the base that caught popcorn while crushing). An experimenter demonstrated how to use the artifacts, and after that,

participants could explore the objects themselves. The task was to indicate which of the objects was made for the demonstrated function. While 3- year-olds selected at chance, 4- year-olds and adults selected the optimal over the suboptimal tool. This result shows that children well before 6 years of age understand the causal relation between design and function, casting doubts on the idea that the DIF begins to influence judgments about function at about 6 years of age precisely because that is the age at which the design-function causal relations start to be understood.

In contrast, the ownership account offers a more principled explanation. In this account, the designer owns the idea of the artifact category's function and can control its use. Ownership research has shown that understanding that ideas can be owned emerges at about 6 years of age; later than the understanding of object ownership (Shaw, Li, & Olson, 2012; Olson & Shaw, 2011). Thus, the preference for the DIF may show itself starting at about 6 years of age, because this preference is the same phenomenon described in studies on the ownership of ideas. Further testing of this idea using function judgments as dependent measure, is an important line of future work.

Additionally, the ownership account nicely complements results regarding the conventionality hypothesis. Recall that work on that hypothesis shows that young children may assign function and classify artifacts based on information about any intentional use (idiosyncratic, conventional, DIF), but that around 6 years of age both conventionality and DIF become important for these judgments (with conventionality apparently emerging first). This is consistent with the conventionality hypothesis, because neither conventions nor DIF dominates judgments. However, later on and into adulthood, the DIF becomes central in function assignment and classification, at the expense of conventions, which end up not being much different from idiosyncratic use. The ownership account would argue

that around 6 years of age, children begin to understand that ideas can be owned, and this explains why older children move towards an adult behavior pattern.

One concern regarding this hypothesis is that the ownership of ideas might be a notion specific to some societies (e.g., individualistic societies, societies that put an emphasis on intellectual property). If this were the case, the ownership of ideas hypothesis would have little explanatory value. In contrast, recent research suggests that the ownership of ideas might be an early development in different cultures. In particular, the aforementioned study of Olson and Shaw (2011) found that 6-year-old children disliked characters that plagiarized drawings in the United States, Mexico, and China: three societies that put different emphases on intellectual property protection. An important task for future research is to determine whether ownership of ideas is present in a wider scope of societies.

Finally, it is possible that ownership reasoning has wider consequences on putative cases of essentialist reasoning beyond artifact categories. In one study (Evans, 2001), children's belief in God as the creator of categories was found to correlate with their tendency to reason essentialistically about the nature of animals. In another study (Diesendruck & Haber, 2009), where children of religious and non-religious environments were compared, it was found that belief in God as creator correlated with an essentialist mode of thinking (i.e., an endorsement of stable category membership) about social categories (e.g., race, gender, ethnicity), and with a teleological mode of thinking about animals (i.e., a belief that they were made for something). The ownership account offers a different explanation for these results from the one offered by essentialism. Ownership reasoning suggests that religious children that believe in God as the creator of animate and social categories, reason that God deserves equivalent respect to what we show for the

human designer of an artifact, and therefore, that we should abide by God's assignment of function, and perhaps refrain from changing the Designer's intended category membership.

On closing this section, we want to address a concern raised by an anonymous reviewer: might the ownership account be making the same predictions that an essentialist theory makes, making them empirically indistinguishable? From the discussion above, we hope it is clear that this is not the case. We think there is a plethora of hypothesis specific to the ownership account. The following list provides some idea of the kinds of hypotheses we envision. The ownership account predicts that: the amount of labor involved in creation should modulate the assignment of proper function; just as property can be transferred, the right to assign proper function can be transferred; the first possession heuristic should show itself in the assignment of proper function, such that between two inventors that arrive at the same idea, the one that arrives first is granted with the right to assign proper function; the passage of time should increase the flexibility in the assignment of proper function (i.e., it is easier to reassign an artifact's proper function if it was created a long time ago). Furthermore, all these variables affecting the assignment of proper function, should closely track the development of the understanding that ideas can be owned, showing an inflection point at about 6 years of age.

## **Conclusions**

In this work we have discussed evidence for the preference for the designer's intended function in the assignment of proper function and its centrality for artifact categorization. This bias that emerges at about 6 years of age, characterizes the adult pattern of thought and has been explained as a case of essentialism (either causal or intentional). Purportedly, DIFs are the essences of artifacts. However, this explanation runs



against evidence showing that under some experimental conditions, current function is more central than DIF, and that the latter does not show much evidence of being perceived as causal of other artifact properties. Motivated by this contradiction, we discuss normative accounts of the relevance of designer's intended function. In normative accounts, people do not reason about what an artifact is causally efficient for, nor about the intentions of an artifact's designer per se, but about how an artifact ought to be used.

One such account appeals to conventions, and holds that DIFs may derive their weight from their association with the way in which artifacts are typically used (i.e., DIFs hint at how artifacts are used most of the time). Evidence suggests that this is only part of the story. Though children around 6 years of age use conventional function as an indicator of proper function, older children and adults tend to disregard conventional functions and prefer to assign functions to artifacts and to conceptualize them according to their DIF.

A second normative explanation complements the convention-based account. In the ownership explanation, the designer acquires the right to assign artifact function (and consequently to define the artifact category) by virtue of owning the idea. The idea of artifact function comes to be owned by the designer by virtue of that person being the first to intentionally create the artifact that fulfills that function. Just as having ideas in general grants their owners with certain rights (e.g., not to be robbed of their ideas, and to decide whether or not others can use them), designers of artifacts would have the right to assign those artifacts' functions. This explains why older children and adults assign function and categorize artifacts in accord to their designer's intended function and not according to an idiosyncratic or even to a conventional alternative function. The relevance of DIF for the assignment of proper function starting at about 6 years-of-age is consistent with the development of idea ownership at the same age.

The ownership account also explains why DIFs continue to be relatively central when compared to alternative information that is also relevant for the assignment of function. Normative function contributes to function assignment and artifacts categorization independently from other sources of information, such as causal reasoning. Precisely because of this, DIFs continue exerting their normative influence in the context of multiple sources of information (i.e., artifact physical structure, agent actions, functional outcomes), though their influence needs not be as critical as when DIFs are directly contrasted against an alternative current function.

In conclusion, in the current work we have discussed evidence that DIFs orient artifact proper function assignment and categorization, and reviewed two types of explanations. Though essentialist accounts are widespread in the literature, we show their limitations and compare them to normative explanations. We believe that these latter accounts fit better with existing data, both from children and adults, and offer several points of contact with other cognitive and developmental literatures.

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