Seeds of Science

Principles of Categorization: A Synthesis

Davood Gozli[1]

Abstract

The present article explores the nature of categorization and its role in shaping our relationship with reality. Drawing on Jens Mammen's distinction between sense categories and choice categories, and Eleanor Rosch's principles of categorization, I examine how our attitudes and modes of engagement with categories can reveal important insights relevant not only to psychology but other scientific fields as well. Furthermore, I argue that the connection between sense and choice categories can be traced by examining atypical instances and non-basic-level categories, which highlight the role of subjects embedded in particular situations. In general, categorization is an active process, influenced by our interests and commitments, even though it does not always appear as such. By correcting biases in our treatment of concepts and categories, we can ultimately correct our biases in scientific practices, thus revealing the entanglement of categorization with broader epistemological issues.

Introduction

The TV show _Black Mirror_ features an episode called _Hang the DJ_ that tells the story of a man and a woman who meet through a digital dating platform. The software appears to learn from their experiences through time-limited dating and sexual encounters, providing instructions through a personal device and calculating compatibility levels, with the aim of presenting each participant with their best match. Despite liking each other, the software continually pairs our two protagonists with others to expose them to more people. Feeling frustrated with the system's control over their lives, they eventually choose to destroy their devices and escape together, at which point we discover they are computer models in a simulation. The two real-life people have yet to meet each other. Additionally, we discover that the dating platform does not calculate romantic compatibility based on their experience. Instead, the decisive factor is whether two people like each other enough to rebel against the system, across repeated simulations, refusing to continue using the software. The story ends with the two real-life people receiving their compatibility score of 99.8%, not knowing how it was calculated, prepared to meet each other for the first time.

[1] Independent Scholar, Toronto, Canada

Jens Mammen's Categories: Sense vs. Choice

The spirit of the dating platform and the spirit of choosing to exit the platform altogether correspond, respectively, to what the Danish psychologist Jens Mammen describes as *sense* categories (logic of types) and *choice* categories (logic of individuals) (Mammen, 2016). The notion of "compatibility scores" implies the ability to compare pairings numerically and determine equivalent pairings. A pairing with a 70% compatibility score is considered better than one with a 68% score, while two pairings with a score of 70% are considered equivalent. Our protagonists in *Hang the DJ* reject the idea of a quantitatively equivalent pairing, indicating that their relationship is unique and incomparable. Despite their decision, we learn that over 1,000 simulations, they rebelled 998 times, choosing to exit together. This led to their compatibility score of 99.8%. Thus, the protagonists' exit was not counter to the logic of the system, but an integral part of the calculation.

The dating platform in *Hang the DJ* treats all its users and relationships as belonging to a single class, calculating romantic compatibility and creating comparisons and equivalences. Mammen (2016) would describe this treatment as reflecting *sense* categories, which treats individuals solely in terms of "types." Mammen says that using sense categories follows "the logic of the eye" and assigns a passive, spectator position to the category-user. Although the term "logic of the eye" implies a passive subject merely observing and categorizing objects from a distance, it is in fact applicable to action-relevant categories, such as coffee cups, doorknobs, and potential sexual partners, in so far as different instances of the same category are treated as interchangeable, by virtue of having the same functional properties. Therefore, "the logic of the eye" is not limited to passive observation but extends to action. The phrase "logic of the eye" is meant to reflect the idea that one can interact with something, while occupying the relatively detached position of a spectator, such as swiping left or right on a dating app. Throughout the rest of this article, I will use "the logic of types" in association with sense categories, and "the logic of individuals" in association with choice categories.

The logic of individuals regards particular cases as unique and irreplaceable (Orilia, 2010; Strawson, 1959). Indeed, the question of replacing, comparing, or equivalence does not arise within the logic of individuals. When we think of singular objects, like a wedding ring or a childhood home, associated with personal sentiments and history, we do not typically place them within a class of comparable objects. What makes one's childhood home significant cannot be expressed in terms of a comparison between perceptual attributes of buildings and neighborhoods. Unlike classes, individuals are tied to a time, place, historical thread, and network of relationships. Mammen's metaphorical description of choice categories is in terms of "the logic of

the hand," tracing, trajectories, co-existence, and lasting bonds. The distinction casts new light on the old dichotomies between the natural sciences versus the humanities, explanation versus understanding, and causal accounts versus narrative accounts (Dilthey, 1883; Mammen, 2017). To illustrate the distinction, we could consider how the psychological science of emotions tends to follow the logic of types and how different it would be if it were to follow the logic of individuals.

Psychological sciences treat categories of emotions, e.g., anger, in terms of how they could be mapped onto other sense categories, e.g., types of function, types of physiological activity, or types of selective pressure in our evolutionary history. In that approach, even the references to culture and social-linguistic construction of emotions are attempts at describing emotions as *types* of processes, and as such, with the use of sense categories (Lindquist et al., 2022). As a result, we come to understand anger with reference to an evolutionary history, neurophysiological structures and functions, and a sociocultural environment that assists or enables the experience and expression of anger.

By contrast, the logic of individuals does not treat emotions as general types. It begins, instead, by noticing a particular case of anger, for instance, anger in the life of Rufus Scott, a Black musician living in 1950s in New York City, struggling with poverty and racial discrimination.[1] We look to see how Rufus's anger relates to his life as a musician, his sense of identity, and with his suicide. How does he express or suppress anger in his relationships? If we are truly interested in understanding the anger of Rufus Scott, what we want to understand is not anger as a general psychological category, *anger as such*, but Rufus Scott's anger experienced and expressed within the contingent web of facts and events that make up his unique life. A significant difference between the two approaches is that in the latter case, our inquiry into anger involves forming and maintaining bond, and insisting on those bonds, with particular individuals about whom we are inquiring (Krøjgaard, 2016).

Adopting the logic of individuals enables us to expand our thinking about categories beyond the confines of a superficial empiricism that focuses solely on sense impressions and their similarities. This approach is not limited to understanding human emotions and bonds but extends to other domains. For instance, in biological sciences, we may identify the similarities between bat wings and pigeon wings and classify them under the same category of "wings." While that might be a valid treatment for some purposes, by utilizing choice categories, by tracking species as

---

[1] Rufus Scott is a fictional character in the novel, *Another Country*, by James Baldwin. What is significant is the particularity of Rufus, his complex individuality, which is irreducible to types.

"individuals" corresponding to distinct historical threads, we could also recognize that the two wings belong to separate historical and biological lineages (Ghiselin, 1981). We could recognize the same distinction in how we think about countries.[2] For instance, while we may group South American countries together, based on their similarities and shared geography, we can also recognize the different cultural-historical threads that correspond to each country. Any personal attachment we happen to have to a particular country within a group of countries, e.g., significant memories or cultural heritage, might strongly counteract the tendency to group countries together based on geographical or other similarities.

In the story *Hang the DJ*, the problem was that the artificial intelligence (AI) was designed without considering the logic of individuals. The AI placed (a simulation of) people through a series of encounters that had no inherent value or meaning, but only served to calculate the final romantic compatibility score. Based on these observations, the system would pair users with each other, aiming to produce results within the logic of types (e.g., "the system deems you two to be the best match for each other"). Such an approach, which relies on comparisons between types, cannot capture the historical-relational traces of romantic relationships. One cannot be someone's partner without actually being with them for a period of time and having made some kind of decision; One cannot merely observe a relationship and expect to understand with the logic of types. In the story, the entire pool of participants was quantified and sorted in reference to each user; they were assigned not just a person but a set of candidate matches, from which one is recognized as their most suitable match. Thus, the system offers a way to remain a spectator while relying on the individual and concrete experiences of virtual copies. Such a method, therefore, requires denying (or perhaps more accurately: cheating) the reality of time and individuals.

Hang the DJ aligns with the notion that the logic of types and the logic of individuals are incompatible. Types are treated as timeless, unchanging, and belong to a static world. Artificial intelligence seems to excel at applying the logic of types. By contrast, individuals are historical threads, capable of forming contingent yet lasting bonds, across irreversible time. Thus, the logic of individuals seems to escape AI, though in practice the AI assimilates even the choice to exit the system into its type-based calculations (see Birhane [2021] for an examination of the philosophical foundations of AI and its methodology).

But are these two types of categories truly incompatible? Contemplating this question has implications for questions regarding the relationship between the natural sciences

---

[2] I am thankful to the *Seeds of Science* editorial team for suggesting this example, in addition to offering several other helpful suggestions and references.

and the humanities, and their corresponding approaches that rely differently on sense and choice categories. To explore this question further, I turn to Eleanor Rosch's prototype theory of categorization.

Eleanor Rosch & Principles of Categorization Categories

Rosch's prototype theory of categorization offers a method for dividing categories based on typicality or representativeness and level of abstraction. At first glance, these principles seem to apply solely to types, i.e., sense categories, and not individuals. However, it is important to note that sense categories are not uniform or homogenous. For example, the sense category for the color "red" includes a range of electromagnetic frequencies, with some instances more easily categorized as red (prototypes) and others less easily (marginal cases). Other categories, such as "weapon" and "bird," similarly have prototypical and marginal cases. A seagull is a prototypical bird, while a penguin is a less typical case, and a bat is not considered a bird at all. A gun, grenade, and teargas are prototypical weapons, while a shoe or toy could be considered a marginal case. Attention to marginal cases raises the question, "Why is X an instance of the sense category A?", which could bring another question into focus, "Why do *we* choose to categorize X as A, in situation Y?"

In addition to typicality, there are differences in abstractness (Rosch, 1978). According to Rosch, basic-level categories convey the most information with the least cognitive effort. One of Rosch's points is that we do not just use basic-level categories as labels; we perceive the world in terms of them. That is, the world is visible to us, first and foremost, in terms of our basic-level categories. However, there is a circularity in this description, as basic-level categories are, by definition, what is more visible and ready-to-hand. For example, I see an animal and say "lion," which is my basic-level category, while another person says, "east African lion," which is theirs. What is "basic-level" changes with experience, expertise, and the context of thought and communication. Nonetheless, we think and talk in communities, so we can imagine an averaging process over time, in the use of a category both by a collective and by individuals, that determines what is basic-level. According to that process, "lion" is more basic-level than "east African lion". Returning to Mammen's distinction between sense and choice categories, what we might observe is that deviations from basic-level and typical instances of categories serve to reveal subjects and, in doing so, reveal choice categories.

In an international gathering in Hong Kong during 2018, where a few people voiced their unease with the question, "Where are you from?" two Americans in particular, who were from predominantly republican states, added to their introductions that they had not voted for Trump. One remarked, "I never say I am from the US [i.e., base

level category]. I say I am from California [subordinate category]." Our attempts to dissociate ourselves from certain categories is often an attempt on insisting that we do not represent a typical or salient category member that might otherwise serve as points of reference.

Could we say that by moving from basic-level categories to the more specific subordinate categories, we tend to move from sense categories to choice categories? Not necessarily, as long as the use of the category is in the service of conveying a mutually understood type. Moving toward choice categories would require insisting, not on non-belonging to a category, but on belonging in a different way, which would reflect something about an individual history. If I insist on being a democrat, and not a republican, I am insisting on being one type rather than another. Alternatively, using choice categories, I might describe the history of my political activities, which might include inconsistencies and contradictions[3] (e.g., being disillusioned and leaving a political group or cause).

Sense categories are grounded in consensus and shared assumptions about what things are and how they should be described. The use of typical instances of a sense category can hide the fact that a category is being actively used, whereas atypical instances of a sense category highlights the subjectivity of the category user. Consider the following statements: (1) A gun was used as a weapon, and (2) a shoe was used as a weapon. Does the second statement raise more questions in the listener's mind, about the situation described? Why did this person need a weapon? Did they succeed in weaponizing a shoe? The prototypical application hides the subjectivity of the category user, because the act of categorization, i.e., categorizing a gun as a weapon, aligns with norms and expectations. In atypical cases, when a shoe is being treated as a weapon, subjectivity is revealed (Giorgi, 2013). Selecting an atypical member of a category or classifying an object in terms of an unexpected category, makes the *subject* more salient. This points us in the direction of choice categories, with the associated logic of individuals. The sense categories involved, i.e., weapon and shoe, open a path toward using choice categories: (1) when presented with the union of gun and weapon, we are more readily able to see a *sense* category; and (2) when presented with the union of shoe and weapon, we more readily see a choice category ("*this* shoe is being used as a weapon").

A similar point can be made about levels of abstraction. Basic-level categories conceal the subjectivity of category users, whereas subordinate categories raise

---

[3] It is worth emphasizing that one cannot control whether others treat one as a type (with sense categories) or as a unique individual (with choice categories). It might, indeed, be unfair to ask strangers to give up the ease and efficiency of types within the limits of a short interaction.

questions about the people involved and the situations in which they find themselves. For example, consider the 2019 reports in Hong Kong about expired tear-gas canisters being used against protestors. Even if we set aside the higher biochemical risks of using expired tear gas, the relatively specific subordinate category raises more questions about the people responsible for using the tear gas—why did they use tear-gas canisters past their use-by date? The question more readily anchors us to the contingent historical situation of Hong Kong protests in 2019-2022.

When discussing both atypical instances and non-basic-level categories, we are not referring to anomalies, i.e., instances that don't fit into their designated category. Instead, we are referring to *anomalous belonging* to categories, where something does fit within a category but in so doing raises questions or induces surprise. This distinction is especially relevant in our discussion of sense/choice categories, as both atypical instances and non-basic-level categories start with sense categories, such as shoe-as-weapon or teargas past its use-by date, but ultimately lead us towards choice categories, where specific subjects appear to be selecting objects for particular purposes.

When considering a uniform sense category, like apples on a tree, the subject selecting an apple can easily fade into the background (Mammen, 2019). In these cases, the subject does not reveal anything about themselves through their act. We can, therefore, focus on the apple itself, without any apparent lack of information. However, in the case of heterogeneous categories, the act of selection becomes more visible, with the subject's act of selection playing a more prominent role. A shoe is chosen as a weapon or a carrier of a message, not just because doing so readily makes sense, but presumably due to contingent, situational pressures.

To summarize, basic-level categories and typical instances of categories tend to hide the subject, because using them involves conforming to shared norms. To do what is commonly done hides the agency of actors and their capacity to do otherwise. As such, typical instances and basic-level categories offer maximum utility in communication, interaction, cooperation. They are more likely to be used by multiple subjects who share minimal common ground. The subjects "hide" in the use of sense categories, though they are not absent. The logic of types is itself grounded in a history of interaction with the world, indeed particular cases of interactions. If we have to maintain attention on particular cases and individuals can create confusion, especially if we are tracking a large number of individuals, which is why it is useful to step back and adopt the logic of types. It is worth noting that the richness of information contained in sense categories (types) arises from dealing with concrete individuals. In the story of *Hang the DJ,* the system produces sense categories

("soulmates") based on an abundance of actual experience (1,000 simulations) in a simulated reality. Thus, types were generated from particular, concrete instances.

How does recognizing sense/choice categories help scientific research? In some lines of research, we might mistake our own decisions (i.e., a choice category) in describing a situation of inquiry. In other words, how we describe an experimental manipulation might be the product of the particular history of investigation, and an attachment to seeing things in a particular way. Two examples from psychological research would help illustrate this point. The first is a line of research that examines how visual perception would change when observers place their hands near objects of sight (Abrams et al., 2008; Gozli et al., 2012). Hand-object proximity was regarded as the experimental manipulation in several published studies, and we neglected the possibility that this factor might not have the same meaning across different situations. Indeed, Bush and Vecera (2014) found that it mattered whether observers placed one hand or both hands near the objects; Goodhew and Clarke (2016) found that it mattered whether the observers were looking at a simple display or a cluttered display; Thomas (2015) found different effects of hand-object proximity depending on grasp size; and, Adam et al. (2012) found that it mattered whether the hands are moving toward or away from the objects of sight. Thus, focusing on hand-object proximity alone and ignoring the potential impact of other factors (e.g., hand movement, grasp size, display type) reflected the researchers' bias on the basis of earlier studies and prior decisions (Gozli & Deng, 2018).

The second example comes from a line of research on rule-breaking behavior. It has been observed that following a rule tends to be relatively more efficient than breaking the rule, presumably due to the additional cognitive burden of rule breaking (Pfister et al., 2016). However, Wirth et al. (2018) found that the typical performance costs associated with breaking a rule could be eliminated if the rule breaking (a) was committed frequently and (b) was committed recently. In other words, the researchers concluded that the recency and high frequency of rule-breaking increased the efficiency of rule breaking. They assumed that regardless of the frequency and recency of the behavior, the same category ("rule-breaking") would aptly and uniformly describe the behavior. This assumption is inconsistent with research that shows our understanding of rules can change rapidly and flexibly in response what we and others, in fact, do (Ting, 2018). To say that participants are continuing to perform the same type of behavior ("rule-breaking") with higher efficiency, indicates the researchers' commitment to describe the behavior with a fixed label (i.e., their choice category), overlooking the possibility that we might be dealing with two different types of behavior, namely "breaking a strict rule" versus "breaking a rule that is not very serious, because it is frequently broken."

The above examples are not meant to suggest that choice categories are always a source of error in research. They highlight, instead, how unknowing use of choice categories, mistaking our own commitments and decisions for how things are, is the source of error. Researchers' conscious commitment can be an advantage, just as our commitment to understand a particular person's anger leads us to see the complex conditions in which their anger is experienced and expressed, a commitment to obtaining an experimental effect can increase the likelihood of the effect. That is, a researcher who wants to obtain an effect, persistently tracking the presence and absence of the effect under a variety of conditions, is likely to discover the conditions under which the effect is obtained (see, e.g., Roberts [2010] for an example regarding self-experimentation and sleep improvement). The key point is to recognize how our description, including scientific descriptions, reflects in part our prior decisions, commitments, and interests. A label might be too imprecise, because of how many other relevant factors are involved, as in the case of studying visual perception near the hands. A label might be too rigid, failing to capture the changes in what is under investigation, as in the case of rule-breaking behavior research.

Conclusion

Paying close attention to how we use categories, the degree to which those categories reflect generalities that reflect consensus, and the degree to which they reflect our idiosyncratic experiences and commitments, including tacit commitments of an entire scientific community, is essential to scientific research. Paying closer attention to what we presently treat as sense categories, we find the hidden historical traces that provide the basis of shared assumptions. At the same time, our shared assumptions might change, as they often reflect contingent cultural-historical conditions. Using the theoretical framework of Jens Mammen (2016, 2019) helps in sensitizing us to how we use categories, whether or not we are primarily using the logic of individuals or the logic of types.

Drawing further implications for philosophy of sciences would require more time and space. For our purpose, however, we could speculate that the natural sciences are more interested in establishing and working with the logic of types and predictable category memberships, while the humanities are more interested in anomalous category memberships, encouraging attention to individuals and their particularities, and emphasizing the ways in which existing conceptual frameworks cannot do justice to them. In addition, the present article provides further justification for seeking diversity of perspectives within scientific disciplines (Mohlhenrich & Krpan, 2021). Researchers who are "outsiders" with respect to a discipline might be able to detect the contingent choice categories that are treated as sense categories due to

disciplinary consensus. They would, therefore, be able to distinguish between justified shared assumptions and unjustified conventions more easily.

Gardener Comments

Dr. Wanpeng Tan (PhD in physics):
A well written article on the topic of sense / choice categories in psychology, in which I am unfortunately not an expert at all. But it is explained so well that I can understand quite some of it. In our system of concepts and categories, if I may use non-technical language, it is really about the contrast of generalities/consensus vs individualism/idiosyncrasies. I found that it is interesting in the article's discussion of its implications for scientific research. So I'd recommend it for publication in SoS.

However, I'd speculate that the behaviors or effects could be very different in different research fields. In less precise fields (e.g., psychology), as the article presented, research activities may be more prone to error of unknowing use of choice categories. In contrast, similar behaviors could lead to transformative ideas in much stricter physical science fields like physics. The reason behind, I guess, is that less precise fields tend to have a more vaguely-defined paradigm while physical science fields, on the other hand, are much more matured with a typically well-defined paradigm, according to Thomas Kuhn. Further study of this aspect may be very intriguing.

Dr. Mario Pasquato (PhD in physics):
I found this article well written and interesting. I am convinced that it should be published by SoS.

From my point of view, as a heavy user of machine learning techniques in the context of astronomy and astrophysics, I found the discussion of sense and choice categories quite interesting. Classification has been a crucial tool in astronomy at least from the introduction of spectral types of stars (Secchi A. 1866) and machine learning is being leveraged in the field to either build new categories from scratch (unsupervised classification or clustering) or to assign pre-defined categories to objects (supervised learning). Interestingly, there is, within the explainable AI field and also in the adjacent fields of interpretability and fairness, strong interest in developing methods that move beyond mere categorization and take the individual into account. An important distinction in algorithmic fairness is the one between group fairness and individual fairness. Group fairness is an additional constraint imposed on the training of a machine learning model to enforce some measure of uniformity in the treatment of different groups. For instance an algorithm for predicting criminal activity may be required to have a similar true positive rate across different races (equality of

opportunity). This obviously does not ensure that any given individual is treated fairly. Individual fairness attempts to devise schemes to ensure that similar individuals are treated similarly. A discussion of fairness in AI can be found e.g. in Caton & Haas (2020).

Besides fairness, another context where AI deals in individuals is that of providing explanations to the decisions of a model. Counterfactuals can be used to explain a model prediction and to empower a user to change it by acting on the features that caused it. The most common example of this is a machine learning model rejecting a loan application. A counterfactual is, roughly speaking, a virtual individual that is as similar as possible to the one whose application was rejected, while being accepted instead. More generally, data prototypes -that is, individuals- are used to summarize datasets and to highlight their peculiarities. This is discussed e.g. in Molnar 2022, chapter 8.7. The book also covers counterfactuals and other prototype-based methods.

I point this out because it may be of interest to the author, perhaps leading to a more detailed discussion of the relationship between the ideas presented in this article and AI.

Josh Randall:
This manuscript provides an interesting framework for differentiating how scientists interact with the world around them and when the underlying philosophy of noticing is more likely to be revealed. It is particularly useful as a resource to consider what forms of knowledge are reflecting the specific historical knowledge of both the object of study and the knowers. I found two places where this manuscript could be improved from my perspective. The two final examples used in the comparison between sense and choice categories were useful, but the discussion following them felt unrelated. Specifically the mention that these do not represent that choice categories always introduce error and that the use of choice categories can reflect our commitments which are the more likely cause of mistakes were confusing to me. I don't think either of the examples deal with these specific issues, and I think especially the second claim would need more evidence. Philosophical/ideological commitments can easily lead to mistakes, especially the overuse of sense categories when additional historical description is needed, but when can commitment to choice category cause a similar problem? Extending this, is this synthesis a space to think about when choice categories become necessary? Sense categories can work as proxies for large amounts of information, but at what point does specificity of individuals take precedence? This question would be where philosophy of science might benefit the most.

Dr. Payal B. Joshi (PhD in chemical sciences):
The author/s present a unique idea capturing the true essence of Seeds of Science journal. While a singular theme has been used i.e. the TV show explains categorization as we see it or believe to exist, the examples are adequately presented that bolsters the message and the perspectives conveyed to the reader.

It is difficult to separate logical decisions, and hence we, as scientists, label them. If we examine AI, label inputs are critical pursuits and I believe it is an oversimplification of hard sciences and their obsession to categorize.

Thus, the idea presented in the article is unique and warrants exploration, albeit not in natural sciences. I suggest adding at least one illustration to the article.

References

1. Abrams, R. A., Davoli, C. C., Du, F., Knapp III, W. H., & Paull, D. (2008). Altered vision near the hands. Cognition, 107(3), 1035-1047.

2. Adam, J.J., Bovend'Eerdt, T.J.H., van Dooren, F.E.P., Fischer, M.H., & Pratt, J. (2012). The closer the better: Hand proximity dynamically affects letter recognition accuracy. Attention, Perception, & Psychophysics, 74, 1533-1538.

3. Baldwin, J. (1962). Another Country. New York: Dial Press.

4. Birhane, A. (2021). The impossibility of automating ambiguity. Artificial Life, 27(1), 44-61.

5. Bush, W. S., & Vecera, S. P. (2014). Differential effect of one versus two hands on visual processing. Cognition, 133(1), 232-237.

6. Goodhew, S. C., & Clarke, R. (2016). Contributions of parvocellular and magnocellular pathways to visual perception near the hands are not fixed, but can be dynamically altered. Psychonomic Bulletin & Review, 23, 156-162.

7. Gozli, D.G., & Deng, W. (2018). Building blocks of psychology: On remaking the unkept promises of early schools. Integrative Psychological and Behavioral Science, 52, 1-24.

8. Gozli, D. G., West, G. L., & Pratt, J. (2012). Hand position alters vision by biasing processing through different visual pathways. Cognition, 124(2), 244-250

9. Dilthey, W. (1883). Introduction to the Human Sciences. Princeton, NK: Princeton University Press, 1989.

10. Giorgi, A. (2013). Reflections on the status and direction of psychology: An external historical perspective. Journal of Phenomenological Psychology, 44(2), 244-261.

11. Ghiselin, M. T. (1981). Categories, life, and thinking. Behavioral and Brain Sciences, 4, 269-313.

12. Krøjgaard, P. (2016). Keeping track of individuals: Insights from developmental psychology. Integrative Psychological and Behavioral Science, 50, 264-276.

13. Lindquist, K. A., Jackson, J. C., Leshin, J., Satpute, A. B., & Gendron, M. (2022). The cultural evolution of emotion. Nature Reviews Psychology, 1(11), 669-681.

14. Mammen, J. (2016). Using a topological model in psychology: developing sense and choice categories. Integrative Psychological and Behavioral Science, 50(2), 196-233.

15. Mammen, J. (2017). A new logical foundation for psychology. Springer.

16. Mammen, J. (2019). A grammar of praxis: An exposé of "A new logical foundation for psychology", a few additions, and replies to Alaric Kohler and Alexander Poddiakov. Integrative Psychological and Behavioral Science, 53(2), 223-237.

17. Mohlhenrich, E., & Krpan, D. (2022). Amateur hour: Improving knowledge diversity in psychological and behavioral science by harnessing contributions from amateurs. New Ideas in Psychology, 65, 100922.

18. Orilia, F. (2010). Singular reference: a descriptivist perspective. Springer.

19. Pfister, R., Wirth, R., Schwarz, K. A., Steinhauser, M., & Kunde, W. (2016). Burdens of non-conformity: Motor execution reveals cognitive conflict during deliberate rule violations. Cognition, 147, 93-99.

20. Roberts, S. (2010). The unreasonable effectiveness of my self-experimentation. Medical Hypotheses, 75(6), 482-489.

21. Rosch, E. (1978) Principles of categorization. In E. Rosch & B. B. Lloyd (Eds.), Cognition and Categorization. Hillsdale, NJ: Lawrence Erlbaum.

22. Strawson, P. F. (1959). Individuals: An essay in descriptive metaphysics. London, UK: Methuen.

23. Thomas, L. E. (2015). Grasp posture alters visual processing biases near the hands. Psychological Science, 26(5), 625-632.