

Building Blocks of Psychology: on Remaking the Unkept Promises of Early Schools

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Abstract The appeal and popularity of “building blocks”, i.e., simple and dissociable elements of behavior and experience, persists in psychological research. We begin our assessment of this research strategy with an historical review of structuralism (as espoused by E. B. Titchener) and behaviorism (espoused by J. B. Watson and B. F. Skinner), two movements that held the assumption in their attempts to provide a systematic and unified discipline. We point out the ways in which the elementism of the two schools selected, framed, and excluded topics of study. After the historical review, we turn to contemporary literature and highlight the persistence of research into building blocks and the associated framing and exclusions in psychological research. The assumption that complex categories of human psychology can be understood in terms of their elementary components and simplest forms seems indefensible. In specific cases, therefore, reliance on the assumption requires justification. Finally, we review alternative strategies that bypass the commitment to building blocks.

Keywords Theoretical psychology · Schools of psychology · Elementism · Complexity · Ontology · History of psychology · Behaviorism · Titchener · Consciousness

How do psychological researchers select their domain of investigation? One strategy, especially popular among experimenters, begins with choosing a category of capacities (e.g., attention, memory, action) and finding ways in which the capacity has been examined in terms of satisfying some demand in controlled laboratory tasks (e.g., selective attention, recognition or recall, task-switching). This strategy leads to choosing among a set of well-established experimental effects (e.g., Stroop effect, repetition priming, Simon effect, attentional capture, visual masking, and so forth), each corresponding to a style of research, questions, and debates about the underlying

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mechanisms (De Houwer 2011; Meiser, 2011; Newell 1973). This approach carries the assumptions that, first, the domain of psychology is divisible into a set of building blocks, each open to investigation by a separate program of research, and second, investigation in each division must begin by focusing on the simplest forms of behaviour or experience within that division. We use the term *elementism* to refer to these guiding assumptions.¹

Not many present-day empirical psychologists explicitly defend elementism, partly due to the longstanding separation between psychological research and philosophical critique² (e.g., Lamiell 2013). Consequently, divisions among lines of research continues, at times motivated exclusively by the discovery of elementary components of a process; causal theories can be put forth with a disregard for the generalizability of experimental effects across situations; and, claims about psychological concepts can be put forth, uncritically, on the basis of research on simple instantiations of those concepts.

The present article is motivated by the pervasive elementism in the practice of researchers and, moreover, by the researchers' relative silence with regard to both the justification and the consequences of adopting elementism as a guiding principle. Our aim is to clarify what it means to regard elementism as an indefensible guiding principle for research, to demonstrate the way in which a line of work loses its motivation as a consequence of this recognition, and to highlight the role of alternative guiding principles.

The outline of the article is as follows. We begin by examining two historical precedents of contemporary elementism, namely the structuralism³ of Titchener, and the behaviorism of J. B. Watson and B. F. Skinner. That is because a critical outlook towards contemporary elementism arises from considering the similarities between these two movements and, indeed, the themes that emerge from examining the two schools run through the problems of contemporary approaches that preserve the elementist strategy. These themes include the simplicity and isolation of processes under investigation, as well as the problems with the functional significance of conscious experience. We conclude by pointing out approaches that do not share the assumption of elementism.

Structuralism and Behaviorism

Brief overviews of the history of psychology, to which most students are exposed, typically include the two twentieth-century schools of structuralism and behaviorism (e.g., Farrell 2014; Kukla and Walmsley 2006; O'Boyle 2006). Each school is described

¹ We refrain from using “modularity” and “faculty psychology” due to association of these terms with specific debates, e.g., the degree of separation between perception and thought (Fodor 1983). The term “elementism” seems more suitable for the present discussion, both for its broader applicability and for its close association to reductionism (Danziger 1979).

² Green et al. (2013, 2014) characterize this separation in terms of diverging genres of writing during late-19th and early-twentieth century. Klempe (2015) traces the separation to Early Modern period and the fundamental tension between empirical psychology (which confronts particularity), and metaphysics (which aims to achieve universality).

³ In using the term “structuralism”, we refer exclusively to the psychological approach advocated by Titchener, and not the approach to linguistics, and later more broadly to social sciences and humanities, which originated in the work of Ferdinand de Saussure.

and, almost in the same breath, its fundamental flaw is pointed out. We learn how structuralism could not justify the authority it gave to first-person report. Behaviorism, on the other hand, denied the scientific relevance of mental processes. These selective descriptions distinguish the two schools from each other, and they distinguish both from the current state of Psychology. They legitimize contemporary status quo, because most contemporary psychologists commit neither of the two errors. We neither take first-person reports at face value, nor reject the study of mental processes. On the other hand, these selective descriptions fail to highlight important commonalities between the two schools and the possible persistence of those commonalities in current thinking (Valsiner 2012, Chapter 3). Consequently, the manner in which we remember structuralism and behaviorism can conceal their shared elementism and the persistence of this assumption in current research. That this important assumption hides, so to speak, in plain sight justifies re-examining the two schools (see also, Araujo and Marcellos 2017; Beenfeldt 2013; Danziger 1979; Green 2010; Leahey 1981).

By selecting structuralism and behaviorism, we do not mean to imply that the two schools were not criticized in their own time (e.g., Angell 1907, 1913; Wheeler 1925), or that they ever achieved unanimous support (e.g., Green 2015, p. 209). We certainly do not mean to imply that elementism is followed unanimously in contemporary psychological research (e.g., Engeström, 2011; Kagan 2012; Kingstone et al. 2008), or that contemporary researchers who adopt elementist strategies are consciously continuing in the tradition of structuralism and behaviorism. Nevertheless, the elementist strategies are sufficiently popular, and their guiding assumptions sufficiently neglected, to warrant the present analysis. Furthermore, given that structuralism and behaviorism might seem to be rather arbitrary starting points in a critique of elementism, it is worth considering alternative starting points. First, elementism can be traced back to John Locke (1632–1704), and then further back to ancient philosophy (e.g., Billig 2008; Perler 2015). Our choice to begin with the more recent schools is due to the similarity between their goals and the goal of contemporary psychological research, namely sustaining a scientific enterprise. Second, if the target of our critique is contemporary research, then why begin with earlier movements? In this respect, the choice is based on the extensive engagement of the two movements with metatheory, including the issue of elementism. To the extent that metatheoretical commitments are implicit in contemporary empirical research, it is useful to draw attention to historical points at which those commitments and their consequences were treated explicitly (e.g., Green 2010; Lamiell 2007; Smith 1992).

Highlighting the Differences

Structuralism, espoused by Edward B. Titchener, aimed at understanding conscious experience through a method of introspection (Titchener 1898; see also, Evans 1972; Pillsbury 1928). The central goal of this approach was to provide a systematic framework for characterizing experience. If psychology were to have its own domain, then experience had to be approached not in terms of physiological or non-conscious factors, or in terms of behavioral tendencies, but in its own terms, i.e., in terms of a taxonomy of psychological categories (Titchener 1898; see also, Leahey 1981).

The kind of conscious experiences investigated by structuralism were not the everyday experience of meaningful objects and events (Titchener 1912, 1921a). To

emphasize this point, Titchener (1921a) contrasted his psychology with that of Franz Brentano. Whereas Brentano's (1874) work relied on the kinds of everyday experience that are readily accessible to his readers, Titchener aimed to find elements of experience that required both trained observers and controlled experimental settings, which facilitated isolating pure description of elements and excluding meaningful, i.e., interpretive, aspects of observation (Titchener 1912; Green 2010). This was motivated by the goal of providing observer-independent results, and was supported by the assumption that meaning is reducible to the meaningless features of experience. In this regard, Titchener stands in contrast to his teacher, Wilhelm Wundt, who did not regard the experimental study of elementary processes as the proper method for understanding meaningful and higher-order psychological processes (e.g., Danziger 1979, 1980). Describing the elementist underpinning of his method, Titchener stated his goal to be "an account so full and so definite that one to whom the object itself is unfamiliar can nevertheless [...] reconstruct it from the verbal formula." (Titchener 1912, p.165). If the observer includes enough elements in her descriptions of an experience, meaning is inevitably provided as a consequence of the richness of that description (not as a consequence of direct inclusion of meaning).

Furthermore, the structuralist method analyzed experience while excluding the question of mental causation (Titchener 1912; Wheeler 1928). The question of mental causation is concerned with whether or not psychological categories, such as intentions, beliefs, and desires, have a place in the causal accounts of behavior (e.g., Mele 1992, Chapter 2). The exclusion of mental causation as target of investigation meant not examining experience in the context of human activities. In this regard, Titchener again stands in contrast to Wundt, who ascribed a causal role to mental states (see, e.g., Araujo and Marcellos 2017; Danziger 1979; Leahey 1981). An important outcome of sidestepping mental causation was that conscious experience was separated from function. According to such an approach, consciousness might be of no consequence at all, beyond being a passive field of experience.⁴

Structuralism was criticized, by its contemporaries, for neglecting the functional significance of experience. Feelings such as thirst, exhaustion, or anger, the critics pointed out, should be examined for their functional role (e.g., Angell 1907, 1913). While these critics disagreed with *how* structuralism approached consciousness, the behaviorist critique argued for altogether excluding consciousness from Psychology. Watson (1913) pointed out the inability of structuralism to establish consensus over its concepts and findings. After several decades, he argued, structuralism had not agreed on what is meant by an "elementary sensation". Watson also criticized Titchener for repeatedly stating that the behavior of an organism, and even the function of experience, belongs to disciplines other than Psychology (e.g., Titchener 1898, 1912). Furthermore, Watson attacked structuralism for insisting that investigating private, publically unobservable, conscious phenomena would be useful at all (Watson 1913). By addressing publically observable events, a behavioristic Psychology could investigate organisms that are not capable of verbalizing their experience, including infants and non-human animals, giving developmental and cross-species continuity to the

⁴ Araujo and Marcellos (2017) and Beenfeldt (2013) trace this aspect of Titchener's structuralism to the British philosophical movements of his time. Also see Billig (2008), who examines the influence of British Empiricism in psychological thinking.

discipline (Watson 1916). Behaviorism, in contrast to structuralism, aimed to discover causal links and, consequently, prediction and control (Watson 1913, 1917; see also, Smith 1992).

Highlighting the Similarities

The two schools had several important commonalities. Both had an explicit concern about establishing the proper domain of psychological research. An underlying commonality, pointed out by Wheeler (1925, 1928), was the assumption that consciousness and behavior were fundamentally different and, thus, could be investigated separately. Only based on this assumption they could regard one of the two domains as inappropriate for investigation. On one hand, Titchener excluded mental causation and function from the psychological domain. On the other hand, Watson and Skinner excluded conscious experience. Both positions presuppose a divide between consciousness and the physical world prior to announcing one side of the divide as inappropriate for investigation (see also, Klempe 2012, 2015; Stengers 2008).

As a consequence, both schools separated consciousness and function (Watson 1913; Skinner 1987, 1989; Titchener 1921b), which led them to either discard or explain away certain concepts that did not fit into their systems. Within behaviorism, agency was dissolved into the ways in which environment rewarded or punished actions of organisms (Skinner 1984, 1987). The behaviorists acknowledged that an action might appear to have conscious causal antecedents. They rejected the validity of this intuition, however, arguing that conscious antecedents of behavior correlate with, but do not determine, behavior (Skinner 1984, 1987, 1989). The true cause of an action, Skinner argued, is its learned/anticipated consequence. And the consequence of an action is determined by the contingencies afforded by the environment. No role was left for consciousness in the selection and production of behavior.

Structuralism, despite its emphasis on consciousness, did not admit conscious elements that had an active character, such as volition (Titchener 1905). Titchener faced difficulty in classifying *attention* in his framework, rejected the view of attention as a mental act, and described it as a series of sensations, e.g., sensing one's own attentive posture, strain in the eyes, tension in facial muscles, the clarity or vividness of a perceived object (Titchener 1905; see also, Leahey 1981). With this strategy, he rejected the common-sense view of attention and reduced it to passive features of experience. We should also note that Titchener's distrust for ordinary first-person report was similar to the behaviorists'. Whereas the behaviorists rejected the first-person experience as a source of data, Titchener reserved it for the trained introspectionists (Green 2010).

Most relevant for our purpose, both schools worked with the assumption that the phenomena of interest could be investigated by analyzing them into elementary building blocks. Within structuralism, all conscious content was supposedly open to analysis and description in terms of a set of elements, including sensations and feelings. Understanding a conscious experience was assumed to consist of knowing the elements that make up the experience (Titchener 1898, 1905). Similarly, behaviorism reformulated complex behavior in terms of elementary motor responses (Skinner 1984; Watson 1916, 1920). Complex processes of language and thought were believed to be reducible to simple response elements. Indeed, the behaviorists considered

thinking to be a challenge, primarily because of the unobservable nature of thinking given their methods of measurement, rather than because of the complexity of thinking (Watson 1917, pp. 342–3).

For Watson, the basic elements of behavior consisted of motor and glandular reflexes that, by virtue of being vulnerable to conditioning, grounded complex and acquired behavior (Watson 1917). With regard to method, reflexes presented an attractive alternative to what was available to the introspectionists (Watson 1916). A reflex had a clear beginning and end, it could be conditioned (i.e., associated with a neutral stimulus) within a twenty-minute session, did not require prior training of subjects who were capable of verbalizing their experience. The involuntary nature of reflexes offered yet another attraction for the behaviorists. Considering the potential contamination of data by voluntary behavior, Watson wrote: "I have dwelt at some length upon this subject for fear some might advance the view that the conditioned reflex is nothing more than the so-called 'voluntary reaction.'" (Watson 1916, p. 98) After removing this threat, we would still face the challenge of having to formulate voluntary behavior from within a perspective that allows only for involuntary reflexes. This challenge is similar to that of the structuralist who wishes to formulate meaning from within a perspective that does not allow for meaningful description.

An additional similarity of the schools was in their references to physiology. Titchener repeatedly stated how physiology will eventually complement psychological investigation by revealing the neural components of the psychological elements, and addressing the functional gap in his description of psychological phenomena (Titchener 1898; Titchener 1912; see also, Pillsbury 1928). Explaining why the study of action does not concern his program, Titchener noted: "we have heard a great deal about the psychophysiology [...] of voluntary movement. And I think that we can leave these things to take care of themselves" (Titchener 1905, p. 216).

Skinner, in a similar manner, defended behaviorism by pointing out the promises of physiology. When considering, for instance, differences among species in reinforcement learning, he stated that physiology will eventually fill all such gaps in our knowledge (e.g., Skinner 1987). Ultimately, "[p]sychology should confine itself to its accessible subject matter and leave the rest of the story of human behavior to physiology" (Skinner 1987, p. 785). In other words, both schools acknowledged the incompleteness of their systems, but they both argued that the incompleteness would be overcome through advances in physiology, not through complementary approaches in psychology (see, e.g., Araujo 2013; Hacker 2015; Robinson 2016, for critiques of contemporary thinkers similarly overplaying the promise of neuroscience).

In sum, the two schools shared an implicit commitment to the separation between experience and behavior, which served as ground for (a) rejecting one side of the divide as the proper target for psychological study and (b) separating consciousness and function. Both attempted to reformulate and reduce complex psychological phenomena in terms of elementary concepts. And, both maintained the belief that physiology will fill the gaps that were left in their systems of psychology. These tenets were not grounded in empirical findings, but rather guiding principles for empirical investigation.

Despite their shortcomings, we do not advocate a wholesale rejection of the two schools. In particular, the behaviorist attempt to take organism-environment as the unit of analysis, their examination of the functional consequences of psychological concepts, and their critique of common sense intuitions continues to be a source of insight

(e.g., De Houwer 2011). On the other hand, the introspectionists' view that certain psychological categories are accessible from the engagement of trained, informed, and interested observers – rather than the participation of untrained, uninformed, and uninterested subject – is well worth considering (e.g., Blackman 2014; Noë 2012; Sampson, 1981). Nevertheless, some of the core assumptions of the two schools systematically excluded psychological domains such as attention, volition, and thinking, as well as the cultural and symbolic dimension of behavior and experience. In the remainder of this article, we focus on two common features of the schools, namely the elementism and the divide between consciousness and function, which persists in current psychological research.

Persistence of our Elementist Heritage

The weakness of Titchener's project is apparent in the long and practically endless list of elements that resulted from his method. When we, present-day students of psychology, critically point to the long list of (over 40,000) qualitatively unique elements, the target of our critique is not the items in the list or the accuracy of their description. It is the rationale that motivates the creation of the list, and the promise that the list, in its completed form, would enable us to understand all conscious experiences. What we identify as a flaw in Titchener's program is the assumption that the list of elements will eventually prove to be finite, and the possibility of rebuilding the world of experience on the basis of the elements. Similarly, when we criticize behaviorists, we do not reject the findings of their learning paradigms. We, instead, reject the assumption that the same concepts and principles, which render those learning paradigms intelligible, are sufficient to render the entire domain of psychology intelligible (Kukla and Walmsley 2006, Chapters 5–6; Toomela 2016).

In 1973, Allan Newell warned researchers in the then-emerging field of cognitive psychology that their research was producing an increasingly large number of highly narrow paradigms with little transfer or generalizability (Newell 1973; see also, Hommel and Colzato 2015; Meiser, 2011). The separate branches of research are now extended and more numerous, and no single system even attempts to include all the diverse phenomena. In a sense, we are confronted with our own list of elements. Instead of elementary conscious content or elementary reflexes, we are faced with a long list of experimental effects, which promise to contribute to a future unified psychology (e.g., Robinson 1995, p. 298). Examining the past decades of cognitive psychology, gives the same impression as our brief review of the history of structuralism and behaviorism: what the elementist approaches yield is not unification, but further division. To illustrate this point, we draw on several lines of investigation that reflect a similar analytic approach that characterized structuralism and behaviorism.

Parsing Action and Perception

In an overview of research on action, Herwig et al. (2013) discussed the problem of “individuating” or “parsing”, which concerns how researchers should divide an action into segments. How should we determine when a segment begins and ends? How should we reconcile parsing with the fact that in many activities there are no clear

beginnings and ends, and multiple actions can overlap in time? The common solution to these problems, Herwig et al. wrote, is to construct artificially simple conditions that allow for easily-parsed actions. Isn't this a continuation of an essentially behavioristic solution? *If our concepts do not match the phenomena, then – for the time being – we will create our phenomena in accordance with the concepts.* In addition to the simplicity of the experimental conditions, the repeated measurement required in experimentation has a role in circumscribing the so-called segments of action, and in determining whether those action segments are sensitive to a given manipulation (Hommel 2000). As Watson (1916, p. 97) observed, even an unconditioned reflex is expressed differently as a result of repeated testing – The first expression of a reflex can involve a widespread reaction of the entire body, whereas the later expressions would be increasingly circumscribed and resembling individuated segments of action. Thus, the simplification in research design and the repetitions necessary for obtaining reliable measurement both contribute to the formation of relatively circumscribed action segments that are not, at least on the surface, representative of ordinary behavior.

It is worth asking whether parsing and individuating should remain essential goals for action research. How do we get closer to understanding actions by understanding action segments? If similar segments cannot be identified in ordinary behavior, then the motivation behind this research comes from the assumption that ordinary behavior is composed of such elementary segments. Without this assumption, the research on elementary action segments would lose its motivation due to a failure to encompass aspects of ordinary action.

To illustrate the shortcoming of elementism in action research, it is useful to recall that an action could be described in terms of relatively abstract/distal goals, e.g., turning on the light or attending a lecture, or in terms of relatively concrete/proximal goals, e.g., flipping that particular switch or walking into that particular classroom (Bergner 2016; Pacherie 2008). Elementary action segments tend to belong to the latter (concrete/proximal) category of descriptions, and presupposing that ordinary behavior is composed of elementary action segments implies that the defining feature of any action is a set of proximal features (e.g., movement). This position, as E. L. Thorndike (1946) pointed out, can lead to misleading questions, such as: What changes about an action once it is tied to a particular expectation? For instance, how does the action of flipping a switch change once the actor knows that the switch will turn on a light? The question is misleading because it fails to recognize the comparison is between two different actions, rather than the same action that can be tied to different expectations (also see, Dewey, 1896). Furthermore, it is misleading because it recognizes a difference as genuine only if the difference is in terms of the properties of the elementary action segments.

The goal of segmentation is not unique to action research. In visual attention research, when the selection of a target among distractors is enhanced, researchers – almost as a matter of habit – tend to ask: Is this a case of enhanced target selection, or is it a case of enhanced distractor inhibition (e.g., Lamy et al. 2008; Maljkovic & Nakayama, 1994)? Further divisions are made accordingly, which can lead to separate lines of work devoted to studying facilitatory and inhibitory processes. But these divisions do not necessarily reflect progress in conceptual clarity (Dukewich and Klein 2015), and they are not always justified, particularly when target identification relies on target-distractor relationship (Becker et al. 2013), or the homogeneity among distractors (Duncan & Humphreys, 1989; Treisman and Sato 1990,

Experiment 4). A red rose is easy to see against a uniformly green field, because of the uniformity of the background *and* the distinction between the background and the rose. In some cases it is reasonable to describe the selection-inhibition process in terms of figure-ground segregation, and it makes little sense to wish to dissect the processes of figure-ground segregation into figure- and ground-processes. The same can be said about the wish to dissect selection- and inhibition-related processes. Moreover, even when visual attention is divided into further components, knowing the characteristics of those elementary components does not enable us to predict how they would function together in coordination (e.g., Kingstone et al. 2008; Ristic and Kingstone 2006). To the extent that examining the isolated components of vision are uninformative about the coordinated function of those components, such an examination loses its motivation.

The elementist approach to visual perception and memory is repeatedly disrupted, due to the legacy of Gestalt psychology. The very concept of a perceptual feature can either be framed in terms of dissociable elements or in terms of relations. Becker et al. (e.g., Becker 2010; Becker et al. 2013) have demonstrated that the feature-based guidance of visual attention is more accurately described in terms of the relation between target features and the surrounding distractors. Pomerantz and Portillo (2011) showed that adding a simple feature to another simple feature does not always result in a multi-featured object, but the emergence of a new basic/irreducible feature. Similarly, Fei-Fei et al. (2005; Li et al., 2002) found that the recognition of complex stimuli that cannot be characterized in terms of a single feature dimension (e.g., natural scenes) does not necessarily require more effort than the discrimination of simpler stimuli (e.g., Ts and Ls). The whole is *different* from the sum of its parts, and “different” does not necessarily mean more complex (Wertheimer 2012, p. 183).

In a related vein, the debate over the units of working memory has largely been framed in terms of elementary features and (multi-featured) objects (e.g., Brady et al. 2011; Fougny et al. 2010; Nie et al. 2017). The underlying question is whether we define an “object”, as Titchener would, as a composite of multiple basic features (in which case, it follows that larger capacity is required for an object, than for a feature) or in terms of emergent features, based on the relation among features (in which case, it does not necessarily follow that larger capacity is required for an object). The former perspective cannot account for the empirical finding that the number of successfully remembered objects is not always reduced with increased complexity, i.e., number of “elementary” features in each object (Awh et al. 2007). Nie et al. (2017) provided a case against describing visual memory in terms of a capacity for separable/individual items. Instead, they showed that visual memory is better described as a hierarchical organization, in which higher-order features are favored over lower-level items. These findings have consequence for how we think about visual memory. In particular, the common practice of estimating visual working memory capacity in terms of a set of individual items seems to be based on a misunderstanding that underestimates visual memory.

It may not be fair, however, to say that analyzing complex processes in smaller parts is always a mistake. It can be shown that perceptual processes, under certain conditions, treat individual features independently, such that one feature does not impact the processing of the other. Manual grasping of objects, for instance, can lead to a more selective processing of grasp-relevant features, relatively to passively viewing the same

object (Ganel and Goodale 2003). Under conditions in which distinguishing between the two features is relatively easy, and when the relevance of the two features to task performance clearly differs, the effect of the two features on behavior can be independent, compared to when distinguishing between the two features is difficult (e.g., Eitam et al. 2015; Hommel et al. 2016). This has been shown, for instance, in the case of upright and upside-down faces (Moeller et al. 2016). With upside-down faces, it is relatively difficult for an observer to dissociate face identity and emotional expression, and the two features are not processed independently of each other. With upright faces, by contrast, it is relatively easy to distinguish face identity and emotional expression, and the two features can have independent effects on performance (Moeller et al. 2016). Thus, investigating the mechanisms underlying feature processing could, under certain circumstances, be carried out in isolation. However, independence of a process cannot be assumed a priori because of the potential sensitivity to other concurrent processes (e.g., Kingstone et al. 2008; Risko et al. 2016; Ristic and Kingstone 2006). Similarly, a process cannot be dissected through dissecting the experimental manipulation, while assuming the preservation of the dissected subcomponents. Whether a process is isolable (i.e., preserved across varying contexts) for investigation is itself a question.

The Case of Vision near the Hands

The question about the separable nature of processes can be illustrated with the case of the experimental studies of near-hand vision. The question behind this research is: How is vision sensitive to the observer's body? More specifically, how does the observer's hand position influence his/her visual perception? Initial attempts to address this question found that responses to visual items were faster the closer those items appeared to the hands (Hari and Jousmäki 1996; Reed et al., 2006). The findings were explained by proposing that the near-hand space is of immediate relevance for action, whereas the space far from the hands cannot be immediately acted upon. Thus, the initial theory was that near-hand space receives priority in processing. Further studies complicated this picture by finding disadvantages in some visual tasks in the near-hand space (Abrams et al. 2008; Davoli et al. 2010). At this point, two research strategies were possible. First, it could be assumed that proximity-to-the-hands is an isolable factor in vision, the effect of which is insensitive to what the observer is doing. Second, it could be assumed that the factor may not have a consistent, context-invariant effect on visual perception and, therefore, its effects should be considered on a case-by-case basis for each task. The latter strategy – given that it does not take hand-proximity as a separable factor in determining visual perception – does not lead to the question "how does vision change in the near-hand space?" The question is incompletely formulated, as it does not specify the activity (manual or otherwise) the observer is engaged in and what visual display she confronts. That is, without assuming that hand-proximity is a separable factor, with a more or less context-invariant effect, the question loses its motivation (Kingstone et al. 2008; Smedslund 2016).

The actual strategy adopted by researchers was an elementist one. That is, we implicitly treated hand-proximity as a separable factor, which is equivalent to assuming that modification in the experimental task, or any addition/removal of variables, would provide further steps toward clarifying the nature of *one and the same effect*. Aiming to unify the various changes in visual processing in the near-

hand space under a single account, Gozli et al. (2012) proposed that the contribution of the action-relevant magnocellular pathway is increased in the near-hand space, while the contribution of the recognition-relevant parvocellular pathway is decreased in this space (see also, Bocanegra and Zeelenberg 2011). Based on the distinct sensitivities of the two pathways, the theory predicts higher temporal resolution, but lower spatial resolution, in the near-hand space. Although the theory accounted for many prior findings, and received support from follow-up experiments (e.g., Abrams and Weidler 2014; Goodhew et al. 2013; Gozli et al. 2014; Huffman et al. 2015; Kelly and Brockmole 2014; Suh and Abrams 2015; Thomas and Sunny 2017), three observations casted serious doubt on its success.

Without going into much detail, we review the three changes in experimental setup that yielded results contrary to the predictions of the theory. First, Bush and Vecera (2014) found that the pattern of findings could be reversed if, instead of both hands, only one hand is placed near the visual display. Second, Goodhew and Clarke (2016) reported that the effect could be reversed when using a relatively cluttered visual display, and pointed out that most previous studies had used simple displays consisting of one or two items. Finally, Thomas (2015) found that the pattern of findings could be reversed, if the observers are asked to adopt a smaller grasp size, as opposed to a wider grasp size. What the three studies had in common was the uncovering of an unexpected variable that reversed the pattern of findings (one hand vs. two hands; complexity of visual display; grasp size). The findings showed that the parameters of the theory cannot be simply confined to hand proximity. Confirming this line of thinking, another research group added hand movement (i.e., whether the hands are moving toward or away from the visual item) to the list of factors that determine vision near the hands (Festman et al. 2013; Wiemers and Fischer 2016). Furthermore, Constable et al. (2015), found that when the task was performed in cooperation with another person, whose hands are far from the visual display, location of the participants' own hands did not influence the results. These studies indicate that seeking a "theory of near-hand vision" amounts to seeking to explain an underspecified situation (i.e., a situation whose description is too abstract and impoverished for successful theorizing; cf., Smedslund 2016; Stenner 2008; Zittoun 2017).

Investigations of vision near the hands have, nevertheless, been useful in demonstrating the embodied nature of vision and the sensitivity of visual processes, such as gestalt grouping (Huffman et al. 2015), figure-ground segregation (Cosman and Vecera 2010), spatiotemporal continuity of visual objects (Goodhew et al. 2013; Gozli et al. 2014), to the observers' hand position. The attempt to pinpoint the nature of hand-proximity, across all circumstances and in terms of a single theory, has not been successful. This, we argue, has been due to the incorrect assumption that the effect under examination is insensitive to task variations. Aiming to understand the nature of an effect by varying the situation rests on the assumption that the effect persists across those different situations. Otherwise, the variations in the situation transform the very target of investigation. In this case, the assumption that hand proximity is an isolable factor, an element in shaping visual perception, has been empirically falsified.

Without the assumption of isolable factors, certain questions would cease to arise as legitimate empirical questions, and certain unifying theories would cease to serve as research goals. Instead, choosing the activity or situation under

investigation could be motivated on practical grounds. If the activity chosen by researchers is intrinsically important, then finding the influence of a factor such as hand-proximity would be important as a matter of practical relevance, regardless of contribution to some general theory.

Experimental Studies of Rule Violation

Our next example concerns a recent series of studies that aim to examine the elementary processes involved in a particular type of behaviors – intentional rule violation (Pfister et al. 2016; Wirth et al. 2016). Researchers used a movement tracking task, in which participants moved an avatar from a start location to one of two target locations. The correct target location was determined by the shape of the avatar, which varied randomly from trial to trial. The task involved a stimulus-response mapping rule with two possible responses corresponding to two possible shapes of the avatar. On a subset of trials, participants were asked to violate the rule (by reversing the stimulus-response mapping). The findings showed that, on “rule violation” trials, movement initiation and movement time were delayed, and movement trajectory deviated from a straight path (curving toward the alternative target location). The researchers claimed that we are beginning to understand the “signature and underlying mechanism of deliberate rule violations” (Wirth et al. 2016, p. 838). This claim is open to critique on several grounds, including whether or not what is under examination is genuine rule violation (Gozli 2017). Here, we focus on the elementist nature of the claim.

If the delayed performance and the deviation of movement trajectory are, in fact, signatures of rule-violating behavior, then (a) these characteristics should not be found in situations in which participants are not violating rules and (b) the same characteristics should be consistently present under different circumstances and across different populations. Both assumptions (a) and (b) have been falsified. In fact, based on the existing findings, a more parsimonious explanation of the “rule violation” effects can be offered in terms of the increased salience of the alternative choice. First, similar variations in performance have been observed without rule violation, but as a result of other changes that also increase the salience of the alternative choice. For instance, if participants know that taking their avatar to location #1 can only be done by taking it to location #2, then the average performance slows down and movement trajectory tends to deviate from a straight line, resembling performance in the “rule violation” condition (Pfister et al. 2014). Moreover, if the non-target location is associated with higher reward, movement trajectory can also deviate toward the non-target location (Hommel et al. 2016). In addition, the delayed performance and deviated movement trajectory, initially regarded as signatures of rule-violation, were not found in the performance of convicted criminals (Jusyte et al. 2017). In short, the one-to-one association between rule violation and changes in performance characteristics cannot be justified, which means the assumption that rule violation, in its simplest and most basic form, is an isolable process cannot be justified.

The lesson, once again, is that an elementist approach, which aims to capture a psychological concept, under simple and controlled conditions seems indefensible. If such an approach is successful, it would mean that a meaningful, context-dependent psychological concepts (e.g., rule violation) could be sufficiently described in terms of elementary, context-independent, non-meaningful features (in line with Titchener’s

structuralism), and that these elementary features consist of variations in performance (in line with behaviorism). The possible success of this approach can be challenged a priori by distinguishing the physical features of an activity (e.g., movement characteristics) from the meaning of the activity within its sociocultural context. Conflating the two is a behaviorist presupposition that has been refuted (e.g., Baars 1986; Bergner 2016; Gozli 2017; Kattsoff 1948). The distinction between meaning and movement is related to the distinction between consciousness and function, to which we turn in the next section.

Consciousness and Function

Where do we stand today with regard to the divide between consciousness and function? As Wolfgang Fasching (2012) noted, discussions of consciousness in contemporary cognitive science are often characterized not in terms of function but in terms of a *qualia*. Within such a framework, behavior is open to scientific investigation, while the ephemeral and private qualia, which may correlate with behavior, stand outside the scientific purview (cf. Zahavi 2007; Cohen and Dennett 2011). Relevant to this separation is Ned Block's (1995, 2005) distinction between *access* consciousness and *phenomenal* consciousness. Briefly stated, a person is access-conscious of an event, if the event makes a difference in the person's behavior (i.e., some behavioral-cognitive process is influenced by the event). By contrast, a person is phenomenally conscious of the event if the event makes a difference in the person's experience (i.e., what it is like to be in the given situation is different by virtue of the occurrence of the event). Block's distinction seems to corroborate the split between behavior and experience and, indeed, the distinction should be viewed in the context of a widespread neglect of the functional significance of experience, i.e., a methodological behaviorism, in empirical investigations of consciousness (Block 1995, pp. 236–7). The split between access and phenomenal consciousness corresponds to the split between the domains of behaviorism (behavior without experience) and structuralism (experience without behavior). As soon as consciousness makes a difference in behavior, it is absorbed (within Block's dichotomy) into the access-consciousness category, which is a category of events that can be captured in third-person descriptions. If any change in behavior can be explained in terms of access to an event, then we could disregard whether that event also corresponds to a change in the (private) domain of experience.

The utility of the distinction between access and phenomenal consciousness can be challenged based on the behavioral effects that can result from a change in conscious experience. In a study that compared the effect of supraliminal and subliminal words in a variant of the Stroop task, Goodhew et al. (2011, Experiment 2) presented participants with a color word ("BLUE" or "PINK" printed in gray) surrounded by dots that were either blue or pink. Participants were asked to, first, report the color of the dots, and then report whether they saw the word inside the dots. The Stroop congruency effect, i.e., faster responses to the dots when their color was congruent with the word, was found when participants detected the presence of the word. Interestingly, the direction of the Stroop effect was inverted when the participants were unaware of the presence of the word, i.e., faster responses in incongruent conditions relative to the congruent condition (Goodhew et al. 2011). Adopting Block's (1995) taxonomy, the observation that detected and undetected words both influenced performance would be evidence for

access consciousness in both conditions. What is difficult to explain is the inversion of the effect associated with the change in phenomenal consciousness.

More strikingly, Persaud and Cowey (2008) asked a person with blindsight to perform a so-called exclusion task, which required pointing to the opposite location of a visual stimulus. In his sighted field, he performed the task accurately, whereas in his blind field he (a) denied the presence of the visual stimulus and (b) was more likely to point to the actual location of the stimulus. It is unclear how such a finding could be explained without ascribing a functional role to phenomenal consciousness, i.e., separating access and phenomenal consciousness.

A more fundamental question is whether manipulating phenomenal consciousness, i.e., comparing responses to the same event *with* versus *without* consciousness, offers the optimal path for understanding the function of consciousness. Influential figures in cognitive science, such as Bernard Baars (1988, 1997), have defended this method. Consciousness, according to this approach, is taken as a variable just like any other, whose value can be manipulated from “0” to “1”. In line with this approach, the recent theoretical work of Morsella et al. (2016) describes consciousness as a field in which multiple objects and action possibilities can co-exist. This field of consciousness, which could be absent (“0”) or present (“1”), enables the integration of competing possibilities, such that one can act with consideration of the entire field. This view, for instance, can account for why phenomenal consciousness is required for performing Persaud and Cowey (2008) exclusion task. Without integrating the actual location of the visual stimulus with the task instruction (“point, not to the actual, but to the opposite location”) accurate performance would not be possible. Nevertheless, Morsella et al.'s (2016), following Baars (1988, 1997), treat consciousness as a variable with one dimension and one kind of consequence (resulting from integration of behaviorally relevant information).

To understand Morsella et al.'s (2016) characterization of consciousness, it is crucial to note their elementist presupposition. They posit, at the outset, that the function of consciousness must be examined in its simplest form (p.3). The theory, thus, contains parameters such as objects (that afford actions) and urges (that motivate actions), but it does not allow for the possibility that an object of consciousness is part of a context of meaning or treated as a symbol. That is, similar to how Titchener excluded meaning and interpretation from his examination of consciousness, Morsella et al.'s elementist approach excludes signs/symbols and sign-mediated activity (see, Baumeister et al. 2011). As Toomela (2016) has argued, the use of a symbol presupposes the difference between the symbol and its referent and, by implication, the possibility of using the symbol differently. The symbol/referent distinction, in turn, implies an integrative function, similar to what is described by Morsella et al., associated with the field of consciousness, but it does not fit into the simplest form of conscious function. Thus, focusing on simple forms of consciousness, associated with relatively fewer attributes, is more likely to neglect attributes that are present in more complex forms of consciousness, rather than provide a foundation for their study (Toomela 2016).

Attention to complex forms of conscious activity reveals that the method of contrast does not exhaust the role of consciousness. In addition to contrasting conscious and non-conscious processes, the contrast can be applied to other attributes of awareness, aiming to compare the different ways in which we can be aware of the same event (Baumeister et al. 2011). According to this approach, consciousness is regarded, not as

a variable among other variables, but as a condition of possibility for a range of other variables. For instance, one way to change phenomenal consciousness is by changing the way we describe an event. Studies have shown that simply changing the meaning assigned to an event, through instructions, can change the pattern of behavior in an otherwise identical task (e.g., Hommel 1993). In their studies of rule-violation, Wirth et al. (2016) found that whether participants regarded reversing the rule as a “reversal” versus a “violation” made a difference in performance – thinking about what they did as a violation accentuated the corresponding changes in performance (presumably by increasing the salience of the original stimulus-response mapping), relative to when they regarded it as a reversal.

Even when the apparent meaning of a message remains the same, changing the language can correspond to a change in behavior (see Hayakawa et al. 2016, for a review). Studies examining how language affects behavior have revealed that using a foreign language can influence individuals’ thinking and decision making (Keysar et al. 2012), moral judgment (Geipel et al. 2015; 2016), and emotional expressions (Ayçiçeği and Harris 2004; Javier et al. 1993). Furthermore, Keysar et al. (2012) examined risk preferences and loss aversion in participants who acquired a foreign language mainly in a classroom setting and did not have a parent who spoke it as a native tongue. They found that using a foreign language, compared with a native tongue, reduced decision-making biases: people relied more on rules when making decisions in a foreign language than when making decisions in their native language. In short, changes in awareness, the meaning ascribed to an event, and the language used to deliver information are accompanied by systematic changes in behavior. Understanding these findings is difficult if we describe consciousness only in terms of access to units of information, and if we attribute no functional role to the phenomenal aspect of consciousness, i.e., meaning, perspective, and interpretation (Baumeister et al. 2011; Bergner 2016; Richardson 2000).

The fact that the link between behavior and consciousness remains puzzling could be attributed to two sources, which have their roots in behaviorism and structuralism. The first source comes from the *a priori* decisions over methodological and conceptual tools in research. If, from the outset, we restrict ourselves to describing action control in terms of associative learning history (Abrahamse et al. 2016) and on-going adjustment in the strength of associations (Hommel 2015; Memelink and Hommel 2013), it would be easy to assume that the conscious experience that accompanies a behavioral expression does not bring any additional explanatory value. Most experimental research is conducted under circumstances in which the meaning and strategy associated with behavior is provided, fixed, and bracketed out by the researchers, which enables excluding participants’ experience when describing the results (Gozli 2017).

The second source is the reactions to the exclusion of experience. These reactions resemble Titchener’s style of argumentation to the extent that they (a) argue for the necessity of returning to experience as the primary target of psychological research and (b) argue for shifting emphasis from explanation (and mental causation) onto description (e.g., Giorgi 2012; Kordeš 2016), (c) aim to analyze experience in terms of elementary components and (d) rely on controlled, artificial settings in which relatively simple stimuli are presented to research participants (e.g., Depraz et al. 2017). Overcoming the current behavioristic methods, therefore, without returning to Titchenerian structuralism requires targeting both experience and behavior (Klempe 2012, 2015; Stengers 2008; Stenner 2008), recognizing the functional significance of consciousness, and abandoning the promise

that the analysis of experiential elements in artificial settings is key to understanding complex psychological phenomena⁵ (Toomela 2016).

To summarize, the divides that were central to the two early schools persist in contemporary research (Hommel and Colzato 2015; Kingstone et al. 2008). We seem to continue in regarding analysis (breaking down complex processes into smaller components) as a desirable research practice; we continue facing difficulty in finding a place for experience and meaning in accounts of behavior. In particular, examining the association between consciousness and function appears to be inadequate if we treat conscious awareness as a one-dimensional variable, which is itself a consequence of basing our claims on simple situations, where awareness is treated as an on/off variable.

Against Elementism

Given the longstanding and varied attempts to overcome elementism in psychology, an historical awareness seems necessary in sustaining such an attempt (Diriwächter and Valsiner 2008; Wagoner 2011). Relevant historical examples include the Gestalt movements in Graz and Berlin with their emphasis on the structures of perceptual experience (Gurwitsch 2009/1936), the Würzburg school with its emphasis on thinking as distinct from sensory processes (Hoffmann et al. 1996), the *Ganzheitspsychologie* movement in Leipzig (Diriwächter and Valsiner 2008), as well as Heinz Werner and Seymour Wapner's studies in cognitive development (Wapner 1964; Werner and Wapner 1952). Instead of discussing the particular approaches, we outline three underlying strategies that seem particularly useful in combatting the elementist tendencies.

A first strategy involves paying close attention to what is present in the context of inquiry, including the conditions of possibility for the very phenomena that is under investigation (Bergner 2016; Giorgi 2014; Hibberd 2014, 2016; Mammen 1993; Toomela 2016). Whereas the elementist approaches insist on eliminating all but a few concepts, the non-elementist strategy insists on faithful observation of phenomena. And, whereas the elementist approaches begin with artificially simple processes (and the aim of augmenting them incrementally), this approach begins with complex processes, including already-occurring human activities in relation to existing cultural contexts and institutions⁶ (e.g., Awad et al. 2017; Wagoner and Brescó 2016; Zittoun 2016, 2017).

For instance, research on action selection can employ an experimental task involving the selection of one out of several response keys (e.g., Fitts and Seeger 1953; Thorndike, 1934). Each response is arbitrarily designated to a stimulus feature (blue square → key #1). Exploring such a task reveals the sensitivity of response efficiency

⁵ It is helpful to remember how Titchener distanced himself from Brentano's project (Titchener 1921a). A characteristic trait of Brentano's psychology was his emphasis on directedness (or about-ness) of conscious states, which recognizes their functional significance (Brentano 1874; see also, Fasching 2012; Tassone 2012). Changing the meaning of objects of consciousness, in Brentano's view, is not only a change in the quality of experience, but it is a functional change that can be expressed in behavior.

⁶ William James (1892, pp. 18-19), among others, contrasted the two approaches in terms of their starting points. The approach favored by James begins with identifying a complex process and analyzing its attributes, whereas the elementist approach begins with an artificially simple process – chosen on theoretical grounds – and proceeds to augment it incrementally.

to various factors, such as the number of stimuli and responses, stimulus-response mapping, repetition, and so forth. Researchers can then construct models of the underlying processes that fit the variations in response efficiency. At the same time, this approach neglects the conditions that enable the investigation, e.g., motivated and compliant research participant, the agreement between the researcher and the participant on what is relevant to the task and how the task is performed, including the mapping between key-press responses and what each key-press signifies. By providing these at the very outset, researchers can focus on modeling performance in terms of an already-selected set of parameters, and sidestep questions regarding why participants engage in the task, what their actions mean, and which aspects of their actions merits focus of investigation. By contrast, an investigation of behavior that does not begin with such constraint has to confront these questions, e.g., what is motivating the behavior? What set of knowledge and skill is being expressed by the behavior? What is the relationship between the relatively overt aspects and the relatively covert intentions and meaning of the behavior? It was for this reason that early critics of behaviorism emphasized the absence of a clear one-to-one link between the overt movements and intentions (e.g., Angell 1913; Kattsoff 1948; Tawney 1915).

Similarly, research committed to a representational theory of perception might limit the scope of analysis to processes internal to the perceiver (e.g., attributes of picture-like entities in the mind). In contrast, drawing attention to the relational nature of perception, its spatiotemporal structure, and its meaning, can overcome this bias (e.g., Hibberd 2014; Noë 2012), just as examining the qualitative nature of perception can disclose the role of action in – and the temporally extended nature of – perception (Noë 2012). Insisting on faithful description of psychological phenomena, including categories associated with behavior and personhood, maintains attention to what might be otherwise neglected (Bergner 2016, 2017). As Hibberd (2014) noted, ontological categories are “placeholders for knowledge generally” (p. 167) and, as such, their neglect hides aspects of what is under investigation.

Among the categories associated with human activities *purpose* is one that is often neglected due to elementist commitments (Bergner 2016; Gozli 2017; Marken 1988). This is the focus of a second strategy. This strategy involves replacing (or augmenting) the search for experimental effects, with an inquiry into purpose (Marken 1988, 2009; Powers 1998; Wapner 1964; see also, Awad et al. 2017; Zittoun 2017). The two kinds of search differ, in that a search for effects consists of finding how one set of (independent) variables might cause changes in another set of (dependent) measured variables, which essentially treats the organism as a causal-mechanistic system. By contrast, the study of purpose involves the assumption that the organism, in any given situation, is actively pursuing/maintaining a set of desired states. As Marken (2002, 2009) pointed out, the cognitive revolution preserved the behavioristic assumption of organism-as-a-causal-system while including internal causes into theorizing.

For instance, in the case of two people engaged in a conversation, a mechanical-causal perspective asks how each person receives and responds to each signals, whereas the *purpose-oriented* or *control system* perspective asks which variables are being maintained at a desired level during the dialogue, e.g., the physical distance, the loudness of their voices, their rate of eye contact, and alignment of other linguistic and gestural features (Garrod and Pickering 2004). Consequently, instead of describing a series of events that begin with a stimulus and end with a response, the control theory

approach brings to focus the agent, its environment, and the ongoing process of interaction between them. This approach, furthermore, can accommodate the functional roles of conscious experience by noting the qualitative aspects of control, e.g., the subjective experience of disturbances or restorations in a controlled variable.

A challenge in finding controlled variables is that, unless a disturbance is introduced, these variables and their on-going maintenance might be concealed (Marken 2009, 2013). This insight brings into view the active role of researchers who must rely on disturbances in order to test for controlled variables. In addition, the language of purpose offers a perspective equally applicable to researchers and research participants. Otherwise, while maintaining a mechanical-causal description of participants' performance, researchers and their purpose would fall beyond the scope of inquiry (Giorgi 2014). This leads us to the third strategy, which is more directly concerned with the motivation behind research.

If the aim of psychology is finding repeatable causal patterns, and finding how the processes under investigation reflect general principles, then the fulfillment of this aim requires removing particularities of the processes, including the researcher's perspective and values. A hermeneutic approach offers an alternative system of value that favors (a) participation over detached inquiry, (b) change over discovery, (c) particularity over universality, and (d) context-dependence over context-independence (Kagan 2012; Richardson 2000; Valsiner 2009). In this approach, psychology is conceived more as a practice, as path toward change, rather than a path toward the discovery of repeatable causal patterns (Engeström, 2011; Smedslund 2012, 2016).

Whether or not the three strategies are complementary is open to debate. What is common to them is that they all go against the pervasive elementism in psychological research. They represent steps toward enriching the view of what is under investigation. They highlight – and offer alternative ways of thinking about – the role and purpose of researchers.

Conclusion

Abandoning the elementist promise in psychology does not merely involve re-interpreting empirical findings. Rather, abandoning the promise can, in many cases, undermine the motive for studying psychological processes in their simple and isolated form. The simpler processes are neither sufficiently representative of the complex processes, nor are they sufficiently stable in their own right. To the extent that current research relies on the promise of elementism, it runs the risk of neglecting attributes of complex psychological phenomena (Toomela 2016). We traced back this form of neglect to both structuralism and behaviorism, which had similarly excluded phenomena from the domain of psychology. Although both schools upheld a framework within which examining the building blocks of experience or behavior were motivated, neither identified a clear and consistent set of elementary processes, and neither convincingly demonstrated how the language of building blocks could expand to encompass the meaningful world of everyday phenomena. Instead, the elementist promise reinforced the divide between the first- and the third-person observation. This corresponds to the divide between conscious experience and behavior that was shared by, although underlying the very separation between, structuralism and behaviorism.

We attempted to demonstrate the persistence of elementism both in shaping and motivating research, and we attempted to demonstrate how certain lines of questioning might lose their force once the assumption of elementism is undermined. Alternative approaches, which do not share the elementist assumption, focus on ontological categories that are necessarily involved in the situation of inquiry. In particular, a focus on purpose works against the elementist style, since it does not neatly fall into either domains of experience or behavior; it opens a way of thinking that is equally applicable to the research participants and the researchers, highlighting alternative ways of conceiving the task of psychology. If we consider analysis and division justifiable, it is only so on a case-by-case basis, and not as a general guiding principle adopted at the outset of a research program.

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Compliance with Ethical Standards

Conflict of Interest Davood Gozli declares that he has no conflict of interest. Wei Deng declares that she has no conflict of interest.

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

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