A Functional-Cognitive Framework for Cooperation Between Functional and Cognitive Researchers in the Context of Stimulus Relations Research

Jan De Houwer¹

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Abstract Contrary to the view that behavior analysis and cognitive psychology are two competing, mutually exclusive approaches in psychology, the functional-cognitive framework for research in psychology postulates that these approaches operate at different but related levels of explanation and therefore can interact in mutually beneficial ways. I briefly describe the framework and explore how it can be applied to research on stimulus relations.

Keywords Levels of explanation · Functional psychology · Cognitive psychology

The current relation between behavior analysis and cognitive psychology is a troublesome one, to say the least. In a recent paper, my colleagues and I likened it to that of two tribes living on different, remote islands in an archipelago (Hughes, De Houwer, & Perugini, 2016a). A few months after that paper appeared in print, I was reminded of this analogy when I attended both the 2016 annual meeting of the Association for Behavior Analysis International (ABAI), which hosted thousands of behavior analysts, and the 2016 annual meeting of the Association for Psychological Science (APS), which hosted thousands of cognitive psychologists. The events took place in downtown Chicago at opposite banks of the Chicago River during the same week, but there were few if any signs of interactions between the attendees of those events.

✉ Jan De Houwer
Jan.DeHouwer@UGent.be

¹ Ghent University, Henri Dunantlaan 2, 9000 Ghent, Belgium

This lack of interaction is not surprising in light of what has been said and written by both sides about the relation between behavioral analysis (or behaviorism more broadly) and cognitive psychology. Cognitive psychologists created the myth of the cognitive revolution (see Watrin & Darwich, 2012, for an excellent review) according to which their approach replaced behaviorism as the dominant approach in psychology, much like one species of animal can supplant another species during natural evolution. This myth implies not only that cognitive psychology is superior to behavior analysis but also that behavior analysis is extinct or well on its way to extinction. Variants of this myth are so widespread in introductory textbooks of psychology that, in all likelihood, the large majority of psychologists who graduated during the past 20 years are blissfully unaware of the achievements or even existence of behavior analysis (Watrin & Darwich, 2012).

Prominent behavior analysts such as Skinner have done little to foster rapprochement with cognitive psychology. On the contrary, Skinner's (1990) claim that cognitive psychology has little or no scientific merit only contributed to the distrust between proponents of both approaches and to the general disinterest in pursuing contacts between these approaches. Rather than trying to discredit cognitive psychology, other behavior analysts clarified the reasons for why the criticisms of cognitive psychologists on behaviorism are incorrect or do not apply to behavior analysis (e.g., MacCorquodale, 1970; Palmer, 2006; Watrin & Darwich, 2012). Unfortunately, most of those counterarguments were ignored by cognitive psychologists, perhaps in part because they were published almost exclusively in behavior analysis journals that cognitive psychologists simply do not read (Palmer, 2006). In the end, if anything, these papers and the lack of response that they evoked from cognitive researchers strengthened the perception that it would be difficult to ever have constructive relations between proponents of the two approaches. Some authors did claim explicitly that behavior analysts and cognitive psychologists can work together in a productive ways, arguing that the two approaches differ primarily with regard to the language that is used (e.g., Slocum & Butterfield, 1994). However, these reconciliation attempts did not receive much attention, either from cognitive psychologists, or from behavior analysts, perhaps in part because they did not fully take into account the fundamental differences that do exist between behavior analysis and cognitive psychology.

In a series of papers, my colleagues and I have argued that functional psychology (including behavior analysis) and cognitive psychology are at the same time fundamentally different and mutually supportive (De Houwer, 2011; De Houwer, Hughes, & Barnes-Holmes, *in press a*; Hughes et al., 2016a). In essence, we proposed a functional-cognitive framework that situates functional psychology and cognitive psychology at different levels of explanation. These levels of explanation differ with regard to the aims that are pursued. By rejecting the idea that functional and cognitive psychology involve competing ways of achieving the same aim, the functional-cognitive framework eliminates much of the basis for conflict between the approaches. Although one still can have a debate about which aims are more laudable, in the end it is difficult if not impossible to solve those debates on rational grounds because they are rooted in values and philosophical considerations (Hayes & Brownstein, 1986). Instead, adopting the functional-cognitive framework implies that one accepts and respects the fact that different researchers can have different aims. The framework also goes one step further by advocating the idea that the functional and cognitive approaches are

mutually supportive in that one approach can help to achieve the aims of the other approach. The framework thus provides a meta-theoretical context in which behavior analysts and cognitive psychologists can interact in constructive ways. In the next section of this paper, I describe the functional-cognitive framework in a bit more detail. In a subsequent section, I put the framework to work by exploring ways in which stimulus relations research could benefit from closer interactions between functional and cognitive researchers.

The Functional-Cognitive Framework for Research in Psychology

Functional and Cognitive Psychology Are Situated at Different Levels of Explanation

Levels of explanation can be defined in terms of their explanandum (i.e., that which is to be explained) and their explanans (i.e., this which is used to explain). From this perspective, functional and cognitive psychology are situated at different levels of explanation because they focus on different a explanandum and explanans (Bechtel, 2005; De Houwer, 2011; see Table 1). More specifically, whereas functional psychology aims to understand behavior in terms of the environment (e.g., Chiesa, 1994), cognitive psychology aims to understand environment-behavior relations (i.e., behavioral effects) in terms of mental mechanisms (Gardner, 1987).

Take the example of classical conditioning, that is, the impact of stimulus pairings (e.g., tone-shock co-occurrences) on behavior (e.g., skin conductance responses to the tone; Pavlov, 1927; Rescorla, 1988). At the functional level of explanation, stimulus pairings provide a potential explanation for the observed change in behavior, that is, for why the tone evokes increasingly strong skin conductance responses during the course of the conditioning phase. Providing this explanation is not a trivial matter because, in principle, other environmental events could be responsible for the increase in skin conductance (e.g., the mere repeated presentation of the shock). Cognitive (learning) psychologists, on the other hand, want to explain classical conditioning, that is, the impact of stimulus pairings on behavior (e.g., the fact that tone-shock pairings result in a stronger skin conductance response to the tone). They do so in terms of mental (i.e., information processing) mechanisms (De Houwer, Barnes-Holmes, & Barnes-Holmes, *in press*). These mechanisms are similar to mechanical mechanisms in which one cogwheel puts in motion another cogwheel which in its turn impacts on other cogwheels. The main difference is that the parts and operations in mental mechanisms involve information that is represented and operated upon (Bechtel, 2008). For instance, it has been proposed that tone-shock pairings produce an association between

Table 1 Explanans and explanandum of functional and cognitive psychology

	Explanandum	Explanans
Functional	Behavior (e.g., skin conductance)	Environment (e.g., tone-shock parings)
Cognitive	Environment-behavior relations (e.g., classical conditioning)	Mental mechanisms (e.g., association formation)

the representation of the tone and the representation of the shock in memory. Once this association has been formed, the presentation of the tone can activate not only its own representation but also the representation of the shock, which in its turn results in an increase in skin conductance (see Bouton, 2016, for a review).¹

The functional-cognitive framework acknowledges that functional and cognitive psychology are fundamentally different. Cognitive researchers will never be satisfied with a functional analysis of a behavioral phenomenon because, for them, such analyses only provide descriptions of the phenomena rather than explanations of those phenomena. Functional researchers, on the other hand, do not need to explain *how* the environment influences the behavior because for them, knowledge about environment-behavior relations suffices to predict-and-influence behavior. These different aims are grounded in fundamentally different philosophical points of view (Hayes, Hayes, & Reese, 1988). There is no point in trying to deny or minimize these differences.

Functional and Cognitive Psychology Can Be Mutually Supportive

Acknowledging these differences does not imply that functional and cognitive researchers cannot interact in mutually supportive ways. On the contrary, by acknowledging that functional and cognitive psychology are directed at solving different problems, it becomes clear that they are not competitors. Unlike to what is often assumed (e.g., Reyna, 1995; Skinner, 1990), the relation between functional and cognitive psychology cannot be reduced to the question of whether behavior is best explained in terms of the environment or in terms of mental processes. From the perspective of cognitive psychology, mental mechanisms do not exist in a void but are shaped by the past environment and activated by the current environment. A true understanding of mental mechanisms can thus be achieved only by taking into account the environment and the effects it has on behavior. This is why cognitive researchers study behavioral effects, that is, specific ways in which the environment impacts behavior (e.g., the Stroop effect). They make inferences about the properties of mental mechanisms based on the way in which the environment influences behavior.

By acknowledging (a) the differences in the aims of each approach and (b) the difficulty of determining the relative merits of those aims (see Hayes & Brownstein, 1986), the functional-cognitive framework provides a context in which functional and cognitive researchers can peacefully co-exist and interact in mutually beneficial ways. The two approaches can be mutually supportive because the levels of explanation at which they operate are interwoven. Most prominently, the functional level provides the input for the cognitive level. That is, functional knowledge (i.e., knowledge about environment-behavior relations) constitutes the explanandum of cognitive psychology

¹ For cognitive psychologists, mental mechanisms encompass not only conscious thoughts and feelings but also unconscious mental processes (e.g., Bargh, 2014). Whereas conscious thoughts and feelings (i.e., private events) can be part of a functional analysis, behavior analysts reject all reference to unconscious events within any type of scientific analysis. However, as I will argue further on in this paper, the functional-cognitive framework does not require that functional researchers endorse the aims and concepts of cognitive psychology. More generally, the merits of the functional-cognitive framework should be judged not on the basis of the perceived merits of the functional and cognitive approaches separately but on the basis of the extent to which the framework facilitates mutually beneficial interactions between both approaches (De Houwer, Hughes, & Barnes-Holmes, *in press b*).

(also see Table 1). Because the cognitive level of explanation is necessarily grounded in the functional level of explanation (Fiedler, 2016), functional researchers can contribute to the explanandum of cognitive models and thereby help to constrain the development of cognitive explanations. The converse is true as well. Because cognitive explanations not only aim to account for existing functional knowledge (their heuristic function) but also to predict novel functional phenomena (their predictive function; see Zentall, 2001), cognitive psychology can also contribute to functional psychology. In sum, the functional-cognitive framework as it was originally proposed (De Houwer, 2011) implies that there is a hierarchical and mutually beneficial relation between the functional and cognitive level of explanation.

Effect-Centric Versus Analytic-Abstractive Functional Research

As noted by Hughes et al. (2016a), the original functional-cognitive framework did not make explicit the fact that functional and cognitive psychologists tend to engage in different types of functional analyses. Most functional psychologists, including behavior analysts, adopt an analytic-abstractive functional approach that tries to capture the relation between environment and behavior in terms of general functional principles that are at the same time precise and broad in scope (Barnes-Holmes & Hussey, 2016). One such principle is reinforcement, which can be applied to a wide variety of phenomena including rats that press a lever because this results in food, as well as children crying because this results in parental attention. Cognitive psychologists, on the other hand, tend to describe environment-behavior relations in effect-centric, topographical ways. For instance, the Stroop color-word effect has been described as the difference in time needed to name the ink color of a color word that refers to the same color (e.g., say “blue” to the word BLUE presented in blue ink) compared to the ink color of a color word that refers to a different color (e.g., say “red” to the word BLUE presented in red ink). This is a functional definition of the effect because it refers only to behavior (speed of responding) and elements of the environment (the relation between ink color and word meaning) but it is effect-centric because it is tied into the surface features of the stimuli and behaviors that are specific to this particular effect.

A behavior analyst, on the other hand, might describe the Stroop color-word effect in terms of the general functional principle of stimulus control, that is, the impact of discriminative stimuli on operant behavior (i.e., the fact that word meaning moderates the extent to which ink color controls responding; see Liefoghe & De Houwer, 2016, for more details). This analysis is much more abstractive in that it links one specific effect (i.e., the Stroop color-word effect) to a much broader class of phenomena (i.e., instances of stimulus control) by pointing out how the stimuli and responses involved in the specific effect take on the same functional role as stimuli and responses in those other phenomena (e.g., that the ink color and the color word function as discriminative stimuli which compete for control over color naming responses). Cognitive psychologists are less inclined to seek abstraction at the functional level because they achieve abstraction at the mental level. For instance, by explaining the Stroop color-word effect in terms of a general mental process such as stimulus-response conflicts in memory, the Stroop effect can be linked to many other effects that are also assumed to be due to stimulus-response conflicts (De Houwer et al., *in press a*).

Ways in Which Functional and Cognitive Psychology Can Be Mutually Supportive

The (updated) functional-cognitive framework (Hughes et al., 2016a) clarifies different ways in which functional and cognitive psychology can be mutually supportive. Let us start with what cognitive psychologists could gain from interacting with functional researchers (see De Houwer et al., *in press a*, for an in depth discussion). Most importantly, the analytic-abstractive analyses that functional researchers typically engage in could be useful also for cognitive psychologists. First of all, because these analyses are strictly functional, they allow cognitive researchers to describe to-be-explained behavioral effects without invoking explanatory mental constructs. All too often, cognitive researchers define a behavioral effect in terms of a specific mental process, thus effectively treating the behavioral effect as a proxy for that mental process (e.g., the Stroop effect as a proxy for stimulus-response conflicts). This practice is known to entail many risks that can be avoided by using (analytic-abstractive) functional definitions of behavioral effects (see De Houwer, 2011, and De Houwer et al., *in press a*, for a more details). Furthermore, because of their abstractive nature, analytic-abstractive analyses of behavioral effects can reveal links between different phenomena that are all instances of the same general functional principle (see Liefoghe & De Houwer, 2016, for an example). This allows one to explore whether the known moderators of the general functional principle (e.g., stimulus control) also moderate specific behavioral effects (e.g., the Stroop effect). Moreover, it encourages cognitive researchers to develop mental explanations for broad categories of phenomena that are all instances of the same general functional principle (e.g., stimulus control) instead of developing idiosyncratic mental explanations for each individual, topographically defined effect (e.g., the Stroop effect; see Meiser, 2011, for a discussion of this common problem in cognitive psychology).

Functional psychology not only has a lot that it can offer to cognitive psychology but also stands to gain from the cognitive literature. As noted earlier, (good) cognitive theories not only account for known functional knowledge (i.e., the moderators of behavioral effects) but also generate novel predictions about environment-behavior relations. Hence, in principle, behavior analysts could use those theories as tools to increase functional knowledge. A much simpler strategy that does not require knowledge about cognitive theories is to explore the empirical data that cognitive researchers have generated themselves (see Barnes-Holmes & Hussey, 2016, for an excellent discussion of why this might be the most fruitful way in which behavior analysts can profit from cognitive research). The cognitive literature is filled with behavioral effects that can be linked to general functional principles or that highlight voids in the current behavior analytic literature. Once a link has been made between a behavioral effect and a general functional principle (i.e., once analytic-abstractive approach is applied to a specific behavioral effect), the functional knowledge about that effect can be used to learn more about the general functional principle. For instance, by linking the Stroop effect with the principle of stimulus control, functional researchers can explore the literature on the Stroop effect to gain new knowledge about stimulus control (see Guinther & Dougher, 2014, for an example in which the cognitive literature on false memories is linked to the behavior analytic literature on stimulus equivalence).

Putting the Framework to Work in the Context of Stimulus Relations Research

As is evidenced by this special issue, research on stimulus relations is growing in popularity within the behavior analytic community. Because of the great divide between behavior analysis and cognitive psychology, behavior analysts might be less aware of the fact that among cognitive psychologists, the closely related topic of relational processing is an important and popular research topic. In fact, relational processing is widely considered to be the foundation for so-called “higher-order” cognitive phenomena such as language, reasoning, categorization, and planning (see Gentner, 2016, Gentner & Smith, 2013, and Halford, Wilson, & Phillips, 2010, for reviews). At the theoretical level, cognitive researchers have explored the core properties of what they call “relational knowledge” (e.g., the fact that it allows for structure-consistent mappings of relations, that it is compositional, that it is systematic), how relational knowledge is represented and constructed, and how it gives rise to higher-order cognitive phenomena. They have also looked at the neural correlates of relational processing (e.g., Knowlton, Morrison, Hummel, & Holyoak, 2012) and constructed computational models that simulate cognitive phenomena such as analogical reasoning (e.g., Hummel & Holyoak, 2003).

What is perhaps more interesting for behavior analysts is that cognitive research on relational processing has produced a wealth of empirical data on a variety of phenomena such as categorization on the basis of relations (so-called “role-governed categories”; e.g., Jung & Hummel, 2015), the development of relational processing and analogical reasoning during childhood, (e.g., Ferry, Hespos, & Gentner, 2015; Richland, Morrison, & Holyoak, 2006; Thibaut & French, *in press*; see Dumas, Hummel, & Sandhofer, 2008, for a review), relational behavior in nonhuman animals (e.g., Christie, Gentner, Call, & Haun, 2016), the relation between language and relational thought (Gentner, 2016), and the role of analogies in learning and education (e.g., Gentner et al., 2016; Gentner & Smith, 2013). It is striking to see that, despite the large overlap between behavior analytic research on stimulus relations and cognitive research on relational processing, there is little cross-referencing between the two literatures. Although the brief overview that I have provided here does not do justice to the magnitude, richness, and complexity of the cognitive literature on relational processing, perhaps it will help raise awareness among behavior analysts about the existence of this literature, as well as about the opportunities it offers for collaboration with cognitive researchers.

To illustrate that collaborations between functional and cognitive researchers on stimulus relations research are possible and potentially fruitful, I now briefly describe some of the work in which I have been involved. Having been trained as a cognitive psychologist, for many years I examined a phenomenon known in the cognitive literature as *evaluative conditioning*. Research on evaluative conditioning looks at the effects of stimulus pairings on preferences. For instance, repeatedly presenting a neutral face together with a liked, attractive face typically results in an increased liking of the originally neutral face (Levey & Martin, 1975). Cognitive psychologists often thought of evaluative conditioning as a very basic mechanism of association formation via which stimulus pairings influence preferences, thus effectively treating evaluative conditioning effects as a proxy for association formation. About 10 years ago (De Houwer, 2007), I advocated a strictly functional definition of evaluative conditioning as

referring to changes in liking that are due to stimulus pairings. Separating the effect (i.e., the change in liking due to pairings) from the mechanism (e.g., association formation) clarified that evaluative conditioning effects can in principle be due to a variety of mental mechanisms, including propositional mechanisms akin to problem solving. This proposal shed new light on conflicting findings in the literature and gave a new impetus to the field (see Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010, and Hütter & Fiedler, 2016, for reviews).

My newly found appreciation for the functional level of explanation brought me into contact with Dermot Barnes-Holmes and Sean Hughes, who introduced me to Relational Frame Theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001; Hughes & Barnes-Holmes, 2016). One of the implications of RFT is that all kinds of events can function as a relational cue that controls arbitrarily applicable relational responding (AARR). This led us to propose that also evaluative conditioning might be an instance of AARR in which the stimulus pairings function as a relational cue (Hughes, De Houwer, & Barnes-Holmes, 2016b). For instance, repeatedly seeing a neutral face next to a positive face might cause participants to treat the two stimuli as equivalent, which would involve a transfer of the evaluative function of the positive face to the originally neutral face. This novel functional analysis of evaluative conditioning provided an entirely new perspective on this phenomenon. For instance, it highlighted that, at least for verbally able human beings, evaluative conditioning might have more in common with complex forms of verbal persuasion than with simple forms of conditioning in nonhuman animals. Just like persuasive verbal messages can function as a relational cue, so too can the pairing of stimuli.

The proposal that evaluative conditioning and verbal persuasion are both instances of AARR raised questions about how one should conceptualize the differences between those phenomena (see De Houwer & Hughes, 2016; Hughes et al., 2016b). For instance, it seems plausible that evaluative conditioning procedures evoke less reactance and are thus less likely to backfire than persuasive attempts via verbal messages (De Houwer & Hughes, 2016). Sean Hughes and I argued that both the similarities and differences between different instances of AARR can be conceptualized in terms of environmental regularities (De Houwer & Hughes, *in press*). An environmental regularity can be defined as

All states in the environment of the organism that entail more than the presence of a single stimulus or behavior at a single moment in time. It can thus refer to the presence of a single stimulus or behavior at multiple moments in time, the presence of multiple stimuli or behaviors at a single moment in time (as in one-trial learning), and the presence of multiple stimuli or behaviors at multiple moments in time. (De Houwer, Barnes-Holmes, & Moors, 2013, p. 634).

All instances of AARR involve proximal regularities (e.g., stimulus pairings or verbal statements that are present now and that function as relational cues) whose effects on behavior are moderated by an extensive set of distal environmental regularities (i.e., those experiences during childhood that give rise to AARR). Hence, whereas all instances of AARR have in common their dependence on those distal regularities, different types of AARR can be distinguished on the basis

of the proximal regularities that are involved. These distinctions could increase conceptual precision in research on relational behavior (see De Houwer & Hughes, *in press*, for more details). As such, my collaboration with functional researchers such as Dermot Barnes-Holmes and Sean Hughes not only changed the way that cognitive researchers look at evaluative conditioning but might also have an impact on behavior analytic research on stimulus relations.

Concluding Thoughts

Although I firmly believe that functional and cognitive researchers can learn a lot from each other, I do not wish to create unrealistic expectations. There are many factors that impede a closer interaction (see Barnes-Holmes & Hussey, 2016, and Hughes et al., 2016a, for a more detailed discussion). Because both approaches have their own language and their own way of doing research, it takes time and effort to understand the research that goes on within the other approach (Hughes et al., 2016a). Returning to the analogy of the archipelago that I mentioned at the start of the paper, one could compare it to the struggle of an anthropologist who tries to make sense of the activities of a tribe on a distant island. Moreover, when exploring the cognitive island, expect to meet natives who actively want to avoid or see little reason to approach you (e.g., Proctor & Xiong, *in press*). Remember that because of the myth of the cognitive revolution, many cognitive psychologists believe that behavior analysis was abandoned or at least stopped evolving after cognitive psychology “won” the battle against behaviorism in the 1960s. Hence, few cognitive researchers are aware of the developments in behavior analysis that took place during the last 40 years, including the surge in stimulus relations research on phenomena such as stimulus equivalence and AARR. If one considers how much behavior analysis has advanced during the past 40 years, one can perhaps understand that cognitive researchers are doubtful about what behavioral analysis can offer in terms of understanding complex behavior such as language than thinking (see Goldsmith, *in press*, for an insightful discussion of what cognitive researchers see as the limits of the functional approach). Moreover, whereas the costs can be high, the short-term profits of venturing into the cognitive literature are uncertain. Much of what is happening in cognitive psychology might be trivial or uninteresting for functional researchers and vice versa (Barnes-Holmes & Hussey, 2016).

Nevertheless, in an age when science is becoming ever more interdisciplinary, it is time to create bridges also between the functional and cognitive approaches within psychology. I realize that conceptual papers such as this one will not suffice to change the tide. What is needed are concrete instances of research in which functional researchers have benefited from cognitive research and vice versa. This requires researchers who make the first difficult steps (see Guinther & Dougher, 2014, Hughes, Barnes-Holmes, & Vahey, 2012, Hughes et al., 2016b, Liefoghe & De Houwer, 2016, and Mickes, *in press*, for some examples of those initial steps). Based on a fundamental belief that, in the long run, science can only benefit from exchanges of data, views and ideas, I am convinced that psychology as a whole will profit from improved relations between behavior analysts and cognitive researchers.

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