RUNNING HEAD: FUNCTIONAL-COGNITIVE FRAMEWORK

Psychological Engineering:

A Functional-Cognitive Perspective on Applied Psychology

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Abstract

The functional-cognitive framework for psychological research implies that functional and cognitive researchers operate at two separate but mutually supportive levels of explanation. From a functional-cognitive perspective, all applied psychologists are ultimately directed at the functional level but they can differ in the way they conduct functional research and the degree to which they seek guidance from cognitive models. We propose a taxonomy that encompasses four different types of applied psychology and evaluate the merits of each type. We also argue that applied psychology can be fortified by strengthening its functional core, thus evolving into a more integrated but still diverse discipline of psychological engineering. Finally, we explore the implications of these ideas for applied memory research.

Keywords: functional psychology, cognitive psychology, levels of explanation

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In a recent paper, Hughes, De Houwer, and Perugini (2016) likened the current state of psychological science to an archipelago of islands, each home to a different "tribe" of researchers. The members of the various tribes differ not only with regard to the topics that they study (e.g., psychopathology, social behavior, …) but also with regard to the approach that they adopt when studying these topics. Generally speaking, communication between the different islands is limited. This is particularly the case for two groups of islands, one group that adopts a cognitive approach and a second group that adopts a functional approach. The cognitive approach has dominated psychology for about half a century now. It aims to uncover mental mechanisms, that is, the way in which organisms process information (see Bechtel, 2008; Gardner, 1987). The functional approach, on the other hand, can be linked to behaviorism, at least certain forms of behaviorism such as radical behaviorism as it was introduced by B. F. Skinner (see Chiesa, 1992, 1994; Hayes & Brownstein, 1986) and to more recent scientific approaches such as contextual behavioral science (Hayes, Barnes-Holmes, & Wilson, 2012). Functional psychologists, as we will call them, are interested primarily in the environmental determinants of behavior, that is, in the way that behavior is a function of the (present and past) environment.[1]

The cognitive approach is often thought of as a reaction against and thus as incompatible with the functional approach. For instance, in a column about the state of behaviorism at the centenary of B. F. Skinner's birth, Roediger (2004) cited Tulving who argued that "psychology now designates at least two rather different sciences, one of behavior

1 We use the term "functional" in the mathematical sense of "function of" (i.e., behavior is a function of the environment) rather than in the teleological sense of "function for" (i.e., behavior serves a purpose). This also clarifies the distinction between functional psychology as we see it (i.e., the study of environment-behavior relations) and functional psychology as the approach adopted by a group of American psychologists (e.g., John Dewey) at the start of the 20th century.

and the other of the mind. They both deal with living creatures, like a number of other behavioral sciences, but their overlap is slim, probably no greater than psychology or sociology used to be when the world was young. No one will ever put the two psychologies together again, because their subject matter is different, interests are different, and their understanding of the kind of science they deal with is different. Most telling is the fact that the two species have moved to occupy different territories, they do not talk to each other (any more), and the members do not interbreed. This is exactly as it should be."

The great divide between cognitive and functional approaches in psychology can also be seen in applied psychology. On the one hand, many applied psychologists are inspired by cognitive research and organized in societies such as the Society for Applied Research in Memory and Cognition. On the other hand, there is a sizeable group of applied functional researchers who have their own organizations (e.g., Association for Behavior Analysis International, Association for Contextual Behavioral Science), meetings, and journals. Also in applied psychology, there is little evidence of communication between these cognitive and functional tribes.

In contrast to the position of scholars such as Tulving, in the present paper we argue that much can be gained from a closer interaction between cognitive and functional researchers, also in the domain of applied psychology. In a first section that provides the background for the rest of the paper, we summarize the work of De Houwer (2011) and Hughes et al. (2016) who (a) highlighted the fact that cognitive and functional approaches in psychology are not mutually exclusive but situated at different, mutually supportive levels of explanation and (b) distinguished two ways of doing functional research (i.e., effect-centric and analytic-abstractive). In the second section, we argue that all applied psychology is ultimately directed at the functional level of explanation. At the same time, four types of

applied psychology can be distinguished, including a new type that draws on both general functional principles and cognitive theories. In the third section, we evaluate the relative merits of the four types of applied psychology. In the fourth section, we explore one implication of the idea that all applied research is ultimately functional in nature: it entails that all applied researchers can communicate in functional terms. We discuss ways of promoting communication at the functional level so that applied psychology can evolve into a more integrated but still diverse discipline that could be referred to as "psychological engineering". As such, we hope to provide the blueprint of a future for applied psychology in which the divide between different islands in the psychological archipelago is bridged and communication is not only possible but routine.

Before we start, we would like to point out that the central argument of the paper is inherently abstract in that it is not tied down to specific research topics. Applied psychology covers many areas of research, ranging from applied memory research, engineering psychology, and industrial-organizational psychology, to the psychology of educational tests and measurement. The primary distinction between these different areas of applied psychology concerns the topic that is addressed (e.g., memory, the way humans interact with the physical world, the selection of employees, assessment of educational skills). In this paper, we do not single out specific *topics* within applied psychology but focus on the *approaches* that applied researchers adopt when studying a certain topic (i.e., the functional and cognitive approach and how they relate to each other). As such, we hope that the present paper provides the necessary starting point for the deployment of the functional-cognitive framework in a wide range of areas of applied psychology. Nevertheless, in order to illustrate what the functional-cognitive framework could mean for specific areas of applied psychology, we included a section at the end of the paper in which we discuss some of the

implications of the framework for a research area that is at the core of this journal (i.e., applied memory research).

The Functional-Cognitive Framework for Psychological Research: The Cognitive and Functional Approaches in Psychology are Situated at Two Separate but Mutually Supportive Levels of Explanation

The present paper builds on the functional-cognitive framework for psychological research that was first described by De Houwer (2011; see Hughes et al., 2016, for an update; see Bechtel, 2005, for similar ideas). At the core of this framework lies the idea that the functional and cognitive approaches in psychology are situated at two separate but mutually supportive levels of explanation. Within the functional level of explanation, behavior is explained in terms of the (current or past) environment and the way organisms interact with the environment. For instance, the fact that a dog salivates upon hearing a bell could be attributed to the prior pairing of the bell and food (Pavlov, 1927). Whereas functional explanations identify *which* events in the environment influence behavior, cognitive explanations specify *how* those events influence behavior. More specifically, cognitive explanations describe the mental (i.e., information processing) mechanisms by which events in the environment influence behavior (Bechtel, 2008; Gardner, 1987). For instance, one could argue that the pairing of bell and food leads to associations in memory via which subsequent presentations of the bell can activate the mental representation of the food, which in its turn leads to salivation (e.g., Rescorla, 1988).

The idea that the functional and cognitive approaches are situated at different levels of explanation has implications for understanding the relation between the two approaches. First, it implies that they are not mutually exclusive. Rather than being rivals that compete to achieve the same goal, the two approaches can co-exist because they are directed at different

goals, that is, at answering different questions. More specifically, they involve a different explanandum (that which is to be explained) and explanans (that which explains). Whereas the functional level aims to explain behavior (e.g., salivation) in terms of events in the environment (e.g., stimulus pairings), the cognitive level aims to explain the impact of the environment on behavior (e.g., impact of pairings on salivation) in terms of mediating mental mechanisms (e.g., formation of associations in memory).

There are valid reasons for adopting each type of goal. Functional researchers focus on environment-behavior relations because it allows them to predict-and-influence behavior (Hayes & Brownstein, 1986; Hayes et al., 2012). Whereas prediction can be achieved by verifying the presence of events in the environment (e.g., after observing pairings of bell and food, one can predict that the bell will start to evoke salivation), influence over behavior can be realized by manipulating the environment (e.g., by actively adding bell-food pairings to the environment). Hence, for functional researchers, it is not necessary to go beyond the analysis of environment-behavior relations. Cognitive researchers, on the other hand, do not want to stop at the functional level. For them, explanations are satisfactory only when mediating mental mechanisms have been identified. For instance, a functional explanation of changes in salivation responses (e.g., the bell starts to elicit salivation because of the bell-food pairings) does not specify the mechanism that mediates these changes (e.g., that bell-food pairings cause changes in salivation because they lead to bell-food associations in memory). This sense of lack of understanding can motivate researchers to search for mediating mechanisms. Because of their focus on mechanisms, cognitive researchers often think of functional explanations as mere descriptions of to-be-explained phenomena rather than as a explanations in their own right. This is why, in general, they tend to see little merit in functional research as such, that is, in functional research that is stripped of its implications

for mental mechanisms. Note, however, that this particular perspective on the lack of merit of functional explanations stems from the goals that cognitive psychologists adopt.

A central aspect of the functional-cognitive framework is that it "does not interfere with the goals of a researcher, nor does it pass judgment on those goals or the reasons behind those goals" (Hughes et al., 2016, p. 7). There is no simple way of deciding which level of explanation is most important or worthy of attention. Such decisions can be informed only by the overarching, pre-analytic aims of the researcher, which ultimately find their ground in values and philosophical positions that are difficult to evaluate or compare on objective grounds (Hayes & Brownstein, 1986; Hayes et al., 2012). Within the functional-cognitive framework, both approaches are regarded as having unique scientific merit, thus defusing past discussions about scientific supremacy (see Reyna, 1995, for an example of such discussions).

The functional-cognitive framework not only allows the functional and cognitive approaches to co-exist, it also highlights that they are mutually supportive. In other words, interactions between the functional and cognitive approaches are not only possible but also potentially beneficial for each approach separately. On the one hand, we believe that functional researchers can benefit from cognitive models (i.e., models of mental mechanisms) as well as cognitively-inspired research because it can help them to identify influential environmental determinants of behavior. For instance, cognitive theories of classical conditioning have resulted in novel insights about the conditions under which stimulus pairings (e.g., of bell and food) results in behavioral change (e.g., salivation; see Bouton, 2016, and Rescorla, 1988, for reviews; also see Barnes-Holmes & Hussey, 2016, for a discussion of what functional researchers can and cannot gain from interacting with cognitive researchers). On the other hand, functional research can help cognitive researchers. Because

functional research generates insights about the environmental determinants of behavior (e.g., under which conditions does classical conditioning occur), it can help constrain the development of cognitive models of the mental mechanisms by which the environment influences behavior (see De Houwer, 2011, and Hughes et al., 2016, for more details).

There is, however, an imbalance in the relation between functional and cognitive approaches. Whereas the functional approach might benefit from cognitive models, it can operate also in the absence of such models (Chiesa, 1994). More specifically, it is possible to discover the environmental determinants of behavior even in the absence of models of mental mechanisms. The cognitive approach, on the other hand, always needs to be grounded in functional research (also see Fiedler, 2016). Because information is non-physical (Wiener, 1961), it is not possible for researchers (as physical beings) to observe or interact with information directly (Gardner, 1987). For instance, one cannot directly observe mental representations of bells and food, nor associations between these representations in memory. [2]

Researchers can make inferences about mental mechanisms only by studying how the environment is related to behavior, that is, by engaging in functional research. This is exactly why cognitive researchers conduct empirical research in which they observe or manipulate situations and examine how these situations relate to observable behavior (see also Roediger, 2004).

The idea that cognitive research is necessarily functional in nature is not trivial when considered from the perspective of the functional-cognitive framework. First, it highlights the fact that by doing research, cognitive psychologists can contribute not only to the cognitive level of explanation (i.e., knowledge about mental mechanisms) but also to the functional

2 One can observe neurons and dendrites in the brain but the exact relation between neural and mental events is often unclear (see Vahey & Whelan, 2016, for a functional-cognitive perspective on cognitive neuroscience).

level of explanation (i.e., knowledge of environment-behavior relations) and thus to the goal of predicting and influencing behavior. Hence, it provides a reason for functional researchers to look closely at cognitive research and gives an extra dimension of relevance to cognitive research.

Second, the idea that cognitive research is necessarily functional also sheds new light on the well-known problem of the use of proxies in cognitive research. Because mental processes cannot be observed directly, cognitive researchers sometimes treat the presence of a behavioral effect (e.g., classical conditioning) as equivalent to the presence of a mental process (e.g., association formation; De Houwer, 2011). The use of proxies is grounded in functional research because it depends on the detection of behavioral effects (i.e., environment-behavior relations). However, it confounds the functional and cognitive levels by assuming a one-to-one link between behavioral effects and mental processes. Unfortunately, it is very unlikely that there are one-to-one relations between behavioral effects and mental processes (De Houwer, 2011; De Houwer, Gawronski, & Barnes-Holmes, 2013). For instance, it has recently been argued that many instances of classical conditioning rely on the formation of conscious propositional beliefs rather than simple associations (Mitchell, De Houwer, & Lovibond, 2009). If this is true, then classical conditioning effects cannot be used as proxies of association formation. More generally, the use of behavioral proxies of mental processes relies on a priori assumptions about how the functional (behavioral effects) and cognitive level (mental processes) are related. Because there often is little independent support for these a priori assumptions, there is a considerable risk that a priori assumptions are incorrect and thus that the proxies are invalid (De Houwer, 2011). We therefore believe that cognitive psychology would benefit from a clear separation between the functional and cognitive levels of explanation. This starts by defining behavioral phenomena

in purely functional terms, that is, without using mental concepts. For instance, when classical conditioning is defined functionally as the impact of stimulus pairings on behavior, no assumptions are made about the mental processes that mediate the effect (De Houwer, Barnes-Holmes, & Moors, 2013). Defining behavioral effects in purely functional terms not only maximizes theoretical freedom but also promotes cumulative science. For instance, a functional definition of classical conditioning allows for both propositional and associative cognitive theories and an uninterrupted buildup of knowledge about the moderators of classical conditioning even when ideas about the mechanisms that mediate classical conditioning change (see De Houwer, 2011, for more details).

When viewed from the perspective of the functional-cognitive framework, the idea that cognitive research is necessarily functional in nature also has a third implication: It allows one to see that functional and cognitive researchers tend to conduct functional research in different ways. In the final paragraphs of this section, we briefly describe these two functional approaches that can be characterized as analytic-abstractive and effect-centric (Hughes et al., 2016). We devote quite a bit of space to this distinction because we believe it is has important implications also for applied psychology in general, implications that we will discuss in the next section.

Like most scientists, functional researchers (i.e., researchers whose aim is to determine the environmental causes of behavior) look for general principles that can be applied across a range of situations. They do so by adopting an analytical-abstractive functional approach that looks for commonalities between individual environment-behavior relations in terms of the roles (i.e., functions) of the stimuli and responses that are involved in those relations. For instance, both the lever pressing of a rat in a Skinner box as well as the tantrum of a small child at home can be described as instances of the general functional

principle of reinforcement. All instances of reinforcement have in common that the probability of a behavior (also called the response; e.g., lever pressing; tantrums) is influenced by its consequences (also called the reinforcer; e.g., food; prolonged interactions with parents). Moreover, the extent to which response probability is a function of the behavior-consequence relation can be moderated by a number of factors, including the presence of stimuli (so-called discriminative stimuli) that signal situations in which the response will or will not be followed by the consequence. A functional analysis of a particular situation is considered to be valid if it allows the researcher to predict-and-influence the behavior (e.g., increase lever pressing by strengthening the relation between lever pressing and food; reduce the frequency of tantrums by instructing a parent to ignore the child when it has a tantrum).

Cognitive researchers also look for general principles but they do so at the level of mental mechanisms. They try to identify mental structures (e.g., working memory), processes (e.g., attentional engagement), and representations (e.g., attitudes) that determine behavior in a range of situations. For instance, working memory is assumed to be involved in both calculus (e.g., dividing 214 by 9) and addiction (Shipstead, Hicks, & Engle, 2012). Likewise, attitudes toward smoking could influence a whole range of behaviors (e.g., buying cigarettes, interacting with smokers; Wiers et al., 2007). Because cognitive researchers can achieve abstraction at the level of mental mechanisms, it is less essential for them to also look for abstraction at the functional level. Hence, effects of the environment on behavior are often described in terms of surface (i.e., topographical) features (e.g., the Stroop color-word effect as an effect described by J. R. Stroop that involves colors and words). Because each effect has unique surface features, different effects tend to be studied in isolation, leading to cognitive models that are designed specifically to account for a particular effect or small

groups of effects (Meiser, 2011). [3] Sometimes, it is even assumed on an a priori basis that a single mental process accounts for a specific effect, as is the case when effects are used as proxies for mental processes (see above). In sum, within the cognitive approach, functional research is often effect-centric, that is, focused on individual effects that are described on the basis of surface features.

Although the effect-centric functional approach has potential advantages, it also has downsides. For instance, it tends to result in a fractionated research landscape where there is little interaction between researchers who study different effects (see Meiser, 2011, for an in depth discussion of this problem). The functional-cognitive framework highlights that the problems associated with an effect-centric functional approach can be reduced by engaging in more analytic-abstractive functional research. This offers cognitive researchers the possibility of linking different types of effects without having to make *a priori* assumptions about the mental processes that are involved in the different effects (see Hughes et al., 2016, for a more detailed discussion). For instance, Liefooghe and De Houwer (2016) pointed out that many pivotal behavioral effects in cognitive psychology such as the Stroop effect, Simon effect, and Task-Rule Congruency effect can all be conceptualized as instances of the abstract functional principle of stimulus control. That is, all these effects involve operant responses (i.e., responses that are emitted because of their consequences) whose properties are influenced by the presence discriminative stimuli. Based on this analysis, Liefooghe and De Houwer discovered new links between seemingly different phenomena. Although the

3 Note, however, that descriptions in terms of surface features often do entail some degree of abstraction. For instance, effects can be referred to as Stroop color-word effects independent of the specific colors that are involved. Such abstraction at the structural level (i.e., at the level of the physical components of stimuli and behavior) can vary in degree depending on how abstractly structural components are described. For instance, the concept "environmental regularity" (De Houwer, Barnes-Holmes, et al., 2013) provides a highly abstract structural description of the spatio-temporal properties of events in that it focuses on spatio-temporal components but ignores many other physical components (see De Houwer & Hughes, in press, for a more detailed discussion).

analytic-abstractive functional approach implies that more resources are directed at analyzing environment-behavior relations, it does not stop cognitive researchers from examining the mental mechanisms that mediate those environment-behavior relations. On the contrary, because the cognitive approach must be grounded in functional research, more sophistication at the functional level is bound to lead to more sophistication at the cognitive level (De Houwer, 2011; Hughes et al., 2016).

To summarize, in this section, we argued that the functional and cognitive approaches in psychology are situated at two levels of explanation that address different scientific questions. Because both types of questions are fundamentally different, there is no need for rivalry between the two approaches. Instead, both approaches can strengthen each other. Although the cognitive approach necessarily involves functional research, it tends to adopt an effect-centric rather than an analytic-abstractive approach. Because an exclusively effect-centric approach has certain downsides, cognitive researchers can benefit from adopting a more analytic-abstractive functional approach, that is, from linking their research with general functional principles such as reinforcement and stimulus control.

On the Nature of Applied Psychology

As we noted earlier, also within the archipelago of applied psychology, some islands are inhabited by functional researchers whereas others are home to cognitively-inspired researchers. At the functional side, applied functional researchers scrutinize various kinds of real-life phenomena by linking them with general functional principles such as reinforcement. This approach has been successfully adopted in applied research on a wide range of phenomena such as autism, phobias, addiction, parenting, and education (see Cooper, Heron, & Heward, 2007, and Hayes, Barnes-Holmes, Zettle, & Biglan, 2016, for reviews). At the cognitive side, researchers have put forward cognitive models of important societal and

behavioral problems such as addiction (e.g., Wiers et al., 2007) and depression (e.g., De Raedt & Koster, 2010). By shedding light on the mental processes involved in these behaviors, these models clarify which mental processes have to be changed in order to alter behavior. As such, they orient cognitively-inspired applied psychologists toward the development of interventions that target specific mental processes (see Kinderman & Tsai, 2007, for a clear example of such an approach in clinical psychology). Cognitive bias modification (e.g., Hertel & Mathews, 2011; Koster & Bernstein, 2015; MacLeod, & Mathews, 2012) and working memory training (e.g., Shipstead et al., 2012) are just two of the many cognitive interventions that have received considerable attention in recent years.

One could argue, however, that all applied researchers ultimately operate within the functional level of explanation. First of all, as we argued above, even cognitive research is ultimately functional in the sense that it deals with environment-behavior relations. Second, by its very nature, applied psychology is directed at solving practical problems. Whereas strictly speaking, theoretical cognitive psychologists can strive to uncover mental mechanisms for its own sake (i.e., to achieve a sense of fully understanding a phenomenon), for cognitively-oriented applied researchers, knowledge about mental mechanisms is a means toward an end. From this perspective, one could even argue that cognitively-inspired applied psychologists already adhere to the functional-cognitive framework that we described in the previous section: They use insights from the cognitive level to enrich their search for ways to predict and influence behavior (see Appendix 1 for a discussion of two possible objections against this conclusion).

In addition to the proposal that all applied researchers ultimately operate within the functional level of explanation, a functional-cognitive perspective also reveals different types of applied research. First, we can distinguish between purely functional applied research and

applied research that is cognitively-inspired. Both are directed at the functional level but only the latter involves cognitive models as tools for inspiring functional research. Second, in the previous section of our paper, we described two ways of conducting functional research: effect-centric and analytic-abstractive. Combining both distinctions produces a taxonomy that encompasses four types of applied research (see Table 1): purely functional analytic-abstractive (PFAA), purely functional effect-centric (PFEC), cognitively-inspired analytic-abstractive (CIAA), and cognitively-inspired effect-centric (CIEC). Although we present the taxonomy in categorical terms for presentational purposes, one should conceive of both distinctions as the end points of two dimensions, one that codes the degree to which effects are analyzed in an analytic-abstractive manner (i.e., the degree to which general functional principles are used as a source of inspiration) and one that codes the degree to which cognitive theories are used as inspiration for research.

Table 1

A Taxonomy of Types of Applied Psychology

	Effect-centric	Analytic-abstractive
Purely Functional	PFEC	PFAA
Cognitively inspired	CIEC	CIAA

PFAA research is typically conducted by applied functional researchers who analyze target behaviors in terms of general functional principles such as reinforcement without taking into account possible mediating mental mechanisms (e.g., Cooper et al., 2007; Hayes

et al., 2016). Much of the cognitively-inspired applied research, on the other hand, would qualify as effect-centric (i.e., CIEC). As is the case in cognitive research more generally, in CIEC research, behavioral effects are often treated as proxies for mental processes (e.g., memory span as a proxy for working memory capacity; see Shipstead et al., 2012). Likewise, interventions are often described in terms of the mental process that they are assumed to target (e.g., *attentional bias* training or *working memory* training). In other words, CIEC research makes little use of general functional principles but is inspired by cognitive theories. PFEC research, on the other hand, draws neither on functional principles nor on cognitive theories. Instead, researchers primarily focus on a particular relationship between environment and behavior (e.g., accuracy of eyewitness testimonies) and the moderators of those effects (e.g., the way lineups are organized). CIAA research, finally, is inspired by both cognitive theories and general functional principles. From a purely logical point of view, one might think that this type of research would be very popular because it maximizes the sources from which inspiration can be drawn. At present, however, there are few if any examples of this type of research in the applied psychology literature. We believe that CIAA research has not yet caught on in large part because of the troubled relation between functional and cognitive psychology. The functional-cognitive framework reveals, however, that it is possible to bridge these two approaches and thus puts CIAA research on the map as a viable and promising avenue for applied researchers.

To summarize, in this section, we have argued that applied researchers operate at the functional level of explanation. One can, however, distinguish between different types of applied research (PFEC, PFAA, CIEC, CIAA). In the remainder of this paper, we discuss a number of implications of this functional-cognitive perspective on applied psychology. First, we discuss the relative merits of the different types of applied research. Second, we explore

the implications of the idea that all applied research is ultimately directed at the functional level. Third, we illustrate what it means to adopt a functional-cognitive framework by deploying the framework in the area of applied memory research.

On the Merits of Different Types of Applied Research

From the perspective of the functional-cognitive framework, it is possible not only to distinguish different types of applied research but also to compare the relative benefits of the various types. We present such a comparison in this section, starting with and focusing on CIEC research because this type of research is arguably most typical for this journal.

Cognitively-Inspired Effect-Centric Research in Applied Psychology

As we noted in the first part of our paper, there are a number of risks attached to effect-centric cognitive research, primarily as the result of the frequent use of behavioral effects as proxies of mental processes. In the following paragraphs, we describe research on attentional bias modification (see MacLeod & Mathews, 2012, for a review) to illustrate that these problems could also threaten CIEC research in applied psychology.

Cognitive researchers (e.g., Franken, 2003; Mathews, & MacLeod, 2002; Williams, Watts, MacLeod, & Mathews, 1988) have argued that important behavioral problems (e.g., addiction) are in part due to a bias in orienting attention to certain stimuli (e.g., alcohol related cues). Because of these claims, training procedures were developed to stop people from orienting to those stimuli (see MacLeod & Mathews, 2012, for a review). One such procedure is based on the dot probe task. In this task, two pictures are presented briefly side by side. Immediately after the pictures disappear, a dot appears on the prior location of one of the pictures. Participants are asked to respond to the dot. The logic behind the task is that participants respond faster to a dot when they already attend to the location where the dot appears. Hence, if the dot appears at a location of a picture that draws attention, responding

will be fast. Initially, dot probe effects were used as proxies for attentional vigilance, also by applied (clinical and health) researchers (e.g., MacLeod, Mathews, & Tata, 1986; see Mogg & Bradley, 1998, for a review). Later on, however, it became clear that dot probe effects might reflect not only a tendency to direct attention towards a picture (i.e., attentional vigilance or engagement) but also a difficulty in redirecting attention away from that picture (i.e., attentional disengagement; see Fox, Russo, & Dutton, 2001). Despite efforts to disentangle the two processes (e.g., Koster, Crombez, Verschuere, & De Houwer, 2004), doubts continued to be raised about whether (components of) dot probe effects or related effects can provide a valid index of attentional engagement or attentional disengagement (e.g., Mogg, Holmes, Garner, & Bradley, 2008). Nevertheless, many researchers continued to use (components of) dot probe effects as proxies for attentional engagement or disengagement, probably because the distinction between these two attentional processes is vital in many cognitive models (e.g., De Raedt & Koster, 2010; Mogg & Bradley, 1998).

Cognitively-inspired applied researchers also developed interventions on the basis of the dot probe task. For instance, in order to train people not to attend certain stimuli (e.g., train a heavy drinker not to attend alcohol related cues), the dot probe task can be arranged in such a way that the dot appears most often at the location opposite to the location of those stimuli (i.e., mostly incongruent trials). These kinds of attentional bias modification training have been studied extensively in clinical and health psychology (see Koster & Bernstein, 2015, and MacLeod & Matthews, 2012, for reviews). Research using these procedures qualifies as CIEC research in that it is inspired by cognitive models about the role of attention in behavior and describes interventions in terms of surface features (i.e., tasks involving dot probes) and categorizes them in terms of mental processes (i.e., attention modification) rather than general functional principles (e.g., reinforcement).

The example of attentional bias modification training nicely illustrates the risks of CIEC research. In line with the current uncertainty about dot probe effects as a proxy of attentional engagement, it is not clear which mental processes are altered as the result of dot-probe-based training procedures. For instance, it is possible that participants learn to quickly disengage their attention from the crucial pictures rather than not to shift their attention to those picture. Because disengagement can be conceptualized as an escape response and because escape responses are known to exacerbate rather than solve clinical problems (e.g., Foa & Kozak, 1986), attentional bias training might thus also have negative effects (Van Bockstaele et al., 2014). It is also possible that participants learn to shift their attention *toward* the crucial pictures because the location of those pictures is a reliable predictor of the location of the dot probe (i.e., the dot probe is likely to appear at the opposite location of the crucial picture; Spruyt & Van Bockstaele, 2013). Moreover, different people might be influenced in different ways. In hindsight, the fact that dot-probe-based attentional bias modification training can have multiple, possibly opposing effects might explain why this type of training turned out to be fairly unsuccessful (see Koster & Bernstein, 2015, for a recent evaluation).

Finally, research on attentional bias modification training also illustrates another problem with cognitively-inspired applied research that we have not yet touched upon. In order for cognitive models to be useful tools for applied researchers, the models need to be clear, coherent, and (to some extent) correct. Although accidental discoveries are always possible, it seems unlikely that cognitive models will orient applied researchers toward practical solutions for practical problems if (a) it is not clear what the model is about, (b) it is not clear what it predicts, or (c) it provides a poor model of the mental mechanisms that underlie behavior. From this perspective, it is disconcerting to see that there is still substantial

disagreement about how one should conceptualize attention (e.g., Anderson, 2011) and whether attentional processes actually contribute in a causal way to behavioral problems such as anxiety disorders (e.g., Van Bockstaele et al., 2014).

In sum, the functional-cognitive framework not only allows us to specify the nature of CIEC research but also to identify and help understand the problems that are associated with this popular approach in applied psychology.

Purely Functional Effect-Centric Research in Applied Psychology

What about PFEC applied research? In this type of research, effects are defined only on the basis of surface features such as the type of stimuli that are involved or the type of responses that are observed (e.g., dot probe effects), without making any assumptions about underlying mental processes (e.g., attention). On the one hand, some of the risks of CIEC research (e.g., those resulting from the use of proxies of mental processes) can be mitigated by engaging in PFEC research. On the other hand, the scientific merit of a PFEC approach is limited by the fact that, in the absence of cognitive models or general functional principles, there is little basis for generalizing knowledge from one situation to another situation. Of course, from a purely pragmatic point of view, it does not matter whether solutions for a problem can be conceptualized abstractly in terms of mental processes or general functional principles. What counts most for applied researchers is that problems get solved. Nevertheless, because there is nothing to orient researchers except surface features, a PFEC approach is likely to progress in a slow, haphazard manner. This is why we believe that progress in applied psychology as a systematic endeavor might be hampered if researchers conduct only PFEC research.

Purely Functional Analytic-Abstractive Research in Applied Psychology

We see more merit in purely functional analytic-abstractive applied research because

it can draw upon a vast source of knowledge about general functional principles (e.g., Catania, 2013) as guidance for applied research. To fully understand the guidance that functional principles can offer, it is important to recall that functional principles provide potential explanations of behavior rather than mere descriptions. For instance, saying that the tantrums of a child are an instance of the principle of reinforcement provides one possible hypothesis for why those behaviors are there. More specifically, it implies that the tantrums depend on specific consequences that they had in the past (e.g., a prolonged interaction between the child and otherwise absent parents) rather than merely on eliciting stimuli in the present (e.g., physical discomfort). This explanation is theoretical in the sense that it involves the application of a general scientific principle (reinforcement). It is hypothetical in the sense that the appropriateness of the explanation cannot simply be observed but has to be substantiated by evidence (e.g., by showing that the tantrums dissipate when parents ignore the child when it has a tantrum and interact with the child more when it does not have a tantrum). It is also generative in that leads to testable new predictions. Predictions can be generated by transferring the knowledge that has been gathered about the general principle (e.g., reinforcement) to the specific behavior that is being studied (e.g., tantrums). For instance, based on the fact that operant behavior is known to be more persistent when it has been reinforced only partially (i.e., when the behavior is followed by the reinforcer in some but not all cases; see Catania, 2013), one can predict that it will be more difficult to reduce tantrums in children whose tantrums only occasionally resulted in positive outcomes. As we noted earlier, an explanation in terms of functional principles does not, however, reveal the mechanisms underlying (instances of) those principles. For instance, an explanation in terms of reinforcement does not explain *how* the consequences of a behavior influence its frequency (e.g., how child-parent interactions during tantrums lead to more tantrums). For cognitive

psychologists, this is a crucial limitation, often leading to the complaint that functional explanations are circular at best (i.e., child-parent interaction is a reinforcer because it functions as a reinforcer). However, this cognitive perspective is blind to the fact that reinforcement is a functional principle that explains behavior (e.g., tantrums) in terms of the environment (e.g., child-parent interactions) rather than a mental mechanism that explains how the environment influences behavior. In sum, when taking a step back, it becomes clear that functional principles do offer explanations that are theoretical, hypothetical, and generative.

Nevertheless, PFAA research misses out on the potential guidance that can be offered by cognitive theories. One of the markers of a good cognitive theory is its capacity to generate new ideas about potential moderators of behavioral phenomena (e.g., Gawronski & Bodenhausen, 2015). Cognitive theories can have predictive value even if they are ill-specified and refer to constructs that are difficult to operationalize. To some extent, vague terms might even be inevitable, for instance, when dealing with phenomena that are poorly understood. One could even argue that the freedom of cognitive researchers to use theories and concepts that cannot be specified precisely allowed them to produce such a rich empirical literature on such a wide range of phenomena. Because the empirical evidence that is generated by cognitive researchers contributes to our understanding of environment-behavior relations, functional researchers can benefit from this literature even if they ignore cognitive theories and constructs. This is especially the case for important types of behavior that receive little attention in traditional functional research (e.g., brief and immediate responding; see Hughes, Barnes-Holmes, & Vahey, 2012). In fact, Barnes-Holmes and Hussey (2016) argued that most of the added value of the functional-cognitive framework for functional researchers might be realized by putting them in contact with the paradigms used and topics

studied by cognitive researchers.

Cognitively-Inspired Analytic-Abstractive Research in Applied Psychology

For historical reasons, functional researchers might be reluctant to embrace input from cognitive psychology whereas cognitively-oriented applied researchers might see little merit in interacting with functional researchers. A central aim of our paper is to raise awareness about the fact that these historical divides can be overcome and that doing so could benefit applied psychology as a whole. From the perspective of the functional-cognitive framework (De Houwer, 2011; Hughes et al., 2016), applied researchers can be inspired by both cognitive models and general functional principles, as well as empirical research generated in both the functional and cognitive tradition. In other words, we believe that applied researchers can engage in CIAA research.

In fact, there could well be a multiplier effect when cognitive and analytic-abstractive sources of guidance are combined. First, when a specific phenomenon or intervention can be linked with a more general functional principle, it allows one to utilize not only the functional knowledge about that general principle but also the cognitive models that have been developed to account for other instances of that general principle or the general principle itself. As such, it would reduce the need to develop separate cognitive models for the specific phenomenon or intervention and could even lead to the development of cognitive theories for classes of problems or interventions that are all instances of the same general functional principle. For instance, the fact that Liefooghe and De Houwer (2016) related both the Stroop effect and the Task-rule Congruency effect to the functional principle of stimulus control opens the way for general cognitive theories of stimulus control that might explain both Stroop and Task-rule Congruency effects. At the very least, a CIAA approach would stimulate cross-talk between cognitive research on different problems or interventions. This

would reduce not only fragmentation in applied research but also the probability that specific effects and interventions are used as proxies of (changes in) specific mental processes. In this way, CIAA research cannot only profit from the guidance of both general functional principles and cognitive models but will also be less susceptible to the risks entailed by the use of cognitive models in effect-centric research.

To illustrate some of the benefits of CIAA research in applied psychology, let us return to the example of dot-probe-based attentional bias modification training. From a standard functional perspective (see Catania, 2013, for an overview), the dot probe task involves several operant contingencies. More specifically, a left dot signals that a left response is correct (Left: Press Left => Correct) whereas a right dot signals that a right response is correct (Right: Press Right => Correct). During a standard dot probe task, responding is typically under the control of the dot (i.e., the probability of pressing left and right depends on the location of the dot) but it is also controlled by the preceding pictures (i.e., speed and accuracy of responding depends on which picture is presented where). Hence, in functional analytic-abstractive terms, the dot probe effect can be conceptualized as an instance of stimulus control by task-irrelevant stimuli.

Building on this analysis, research on dot-probe-based training procedures can be conceived of as research on changes in stimulus control by task-irrelevant stimuli, more specifically changes that are due to the strength of the contingency between features of the task-irrelevant stimuli (i.e., the pictures), on the one hand, and the task-relevant stimulus (i.e., the dot) or correct response (pressing the left or right key), on the other hand. We realize that for a cognitive researcher, this analysis is likely to be perceived as an awkward re-description of the dot probe effect and the purpose of dot-probe-based training. It is awkward because it is coined in terms unfamiliar to many cognitively-inspired researchers. It is also unlikely to

satisfy the scientific aims of cognitive researchers because, as a functional description of the effect, it does not refer to any mediating mental mechanisms that could explain the dot probe effect or the effects of training.

Nevertheless, these kinds of functional analytic-abstractive descriptions can have merit for cognitively-inspired researchers. Because it is framed in terms of general functional principles, our description of the dot probe (training) effect makes contact with many other instances of stimulus control in animals (e.g., Escobar & Bruner, 2007) and humans (e.g., Liefooghe & De Houwer, 2016). For instance, it reveals a link between dot-probe-based training and proportion-congruency effects in Stroop studies (e.g., Schmidt & Besner, 2008). From a functional analytic-abstractive perspective, both dot probe effects and Stroop effects qualify as instances of stimulus control by task-irrelevant stimuli (i.e., picture location and words, respectively; Liefooghe & De Houwer, 2016). Moreover, both dot-probe-based training and proportion-congruency effects involve a manipulation of the contingency between task-irrelevant stimuli (i.e., picture location; word) and task-relevant stimuli (i.e., dot location; ink color) or responses (e.g., pressing a left or right key; saying "blue" or "green").

On the basis of this functional analytic-abstractive re-description of dot-probe-based training and proportion-congruency effects in Stroop studies, a link can be made between the two literatures on these effects. More specifically, functional knowledge about proportion-congruency effects in Stroop studies and cognitive models of these effects can be used to inspire research on dot-probe-based training. For instance, it has been demonstrated that proportion-congruency effects are highly stimulus-dependent (e.g., Schmidt & Besner, 2008) suggesting that these effects are not due to conflict adaptation via changes in the deployment of attention to task-irrelevant stimuli. Instead, proportion-congruency effects have been explained by episodic memory models that operate solely on the basis of general principles of

memory storage and retrieval (e.g., Schmidt, 2013). This functional and cognitive knowledge about proportion-congruency effects in Stroop tasks sheds new light on the fact that dot-probe-based training effects show little transfer (i.e., also seem to be stimulus-specific; see Koster & Bernstein, 2015, for a review).

Summary

In this section, we discussed the relative merit of the four types of applied research that we identified in the previous section. Whereas PFEC research is limited as a *systematic* scientific endeavor, CIEC research faces a number of challenges, and PFAA misses out on possible guidance from cognitive models and research, a CIAA approach to applied psychology combines the best of both worlds (i.e., levels of explanation) and can thus maximize progress.

Applied Psychology as Psychological Engineering

There are many barriers that hamper communication between applied psychologists. The functional-cognitive framework reveals ways to overcome these barriers and thus to increase the coherence of applied psychology. First, there is the historical divide between functional psychology (i.e., behaviorism) and cognitive psychology that we mentioned earlier and that still hinders contacts between functional applied researchers and cognitively-inspired applied researchers. The functional-cognitive framework shows that this is an illusory barrier. It is possible for functional and cognitive researchers to interact while maintaining their unique goals and approaches. Because the functional and cognitive approaches can be mutually supportive, increased communication between functional and cognitive researchers can be beneficial for all involved. Second, applied research is fractionated not only along the line of the approach that is adopted (functional, cognitive) but also along the line of the topics that are studied (addiction, eyewitness testimony, …). Based on the functional-cognitive

framework, we propose that unity and communication can be fostered by linking phenomena that are studied in various areas of applied psychology to a common set of general functional principles (e.g., reinforcement). Third, communication between applied psychologists is often hampered by the fact that different researchers use the same concepts at multiple levels of explanation (e.g., conditioning as an effect, as the mental process of forming associations in memory, or as the neural process of forming dendrites in the brain). The functional-cognitive framework can help solve this problem by encouraging researchers to separate different levels of explanation and by defining behavioral phenomena strictly in functional terms, preferably in terms of general functional principles.

In sum, the functional-cognitive framework suggests that communication between applied psychologists can be improved by adopting a common analytic-abstractive language that is phrased in terms of general functional principles. Analytic-abstractive concepts (a) can be used not only by functional researchers but also by cognitively-oriented applied psychologists without precluding the use of cognitive models (e.g., the Stroop effect as an instance of stimulus control; see Liefooghe & De Houwer, 2016), (b) are applicable to a wide range of practical problems and potential solutions (e.g., see our analysis of dot probe effects and dot probe training effects in terms of stimulus control), and (c) are purely functional and thus not conflated with concepts from other levels of explanation. Although it remains to be seen whether a functional analytic-abstractive language can be used to describe all of the phenomena that applied psychologists are studying, it is encouraging that analytical-abstractive functional concepts have been used to describe an extensive range of lab-based and real-life phenomena (e.g., Catania, 2013; Cooper et al., 2007), including phenomena related to language and thought (e.g., Hayes, Barnes-Holmes, & Roche, 2001). [4]

4 While pursuing this direction, care should be taken to keep functional and cognitive concepts clearly

The benefits of creating a common language far outweigh its costs. Once the barriers between applied researchers have been torn down and a common functional language starts to develop, applied psychology can evolve into an integrated but diverse discipline that could be described as "psychological engineering". [5] Within such a discipline, applied psychologists of all denominations can contribute to a joint body of knowledge that is formulated in a common language and can thus be consulted by all current and future applied psychologists. At the same time, applied research can remain diverse both in terms of the topics studied and in terms of the approaches that are adopted. As is the case in many types of engineering, within this diversity there would be a common core that all applied researchers could relate to. Hence, it might be appropriate to use the term "psychological engineering" to refer to this more integrated discipline. Although an increase in integration in no way hinges upon the use of the term "psychological engineering" and although this term might also have negative connotations for some, it does have the advantage of communicating the integrated nature of the discipline and of relating the discipline to other types of engineering. Just like the civil engineer shapes the physical world, so would the psychological engineer help shape the world of behavior. Just like all engineers, psychological engineers would need to be guided by ethical and societal values. In our opinion, the move toward such an integrated discipline of psychological engineering is highly desirable in light of the many problems that we currently face as individuals, as members of societies, and as a species. Many of these

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separated. Cognitive researchers who currently use analytic-abstractive terms tend to interpret these terms in cognitive ways that go well beyond their original functional meaning . For instance, the terms reinforcer and reward are often used interchangeably even though the former one originally had a purely functional meaning (i.e., saying that a child-parent interaction is a reinforcer of tantrums attempts to explain why tantrums are frequent) whereas the latter is typically used in a cognitive manner (i.e., saying that child-parent interaction is a reward attempts to explain why it functions as a reinforcer). Conceptual rigor and training will be vital in building a common analytic-abstractive language. Unlike what is currently the case at most universities, psychology students need to be trained in evaluating the merits of scientific concepts and explanations, as well as educated about the basic principles of learning and behavior.

5 Note that this term should not be confused with the term "engineering psychology". Whereas the first one refers to a general approach that is not tied to a specific topic, the latter one is typically used to refer to one topic within applied psychology (i.e., the interaction between humans and their physical environment).

problems are inherently behavioral (in the broad sense of overt behavior and conscious thought) or the result of human behavior. Hence, applied psychologists have a vital role to play in solving them. We firmly believe that these problems can be tackled more efficiently if we strengthen the functional core that unites applied psychology.

What Does it Mean to Adopt a Functional-Cognitive Framework? The Case of Applied Memory Research

Now that we have developed the argument in largely abstract terms, we discuss some of the implications of these ideas for applied memory research. For cognitively-inspired memory researchers, one of the most important implications is that they can benefit from describing phenomena and empirical findings as much as possible in terms of environment and behavior, that is, without using mental constructs (De Houwer, 2011). At first sight, it might seem difficult to construct functional descriptions of effects and findings in the (applied) memory literature simply because memory research seems to have an inherent focus on mental structures (e.g., memory stores) or mental processes (e.g., encoding and retrieval). However, because mental structures and processes cannot be observed directly, in practice, also knowledge about memory stores and memory processes can only be inferred from knowledge about environment-behavior relations. Therefore, it must be possible to describe memory research in functional terms. For instance, a substantial part of the vast literature on eyewitness testimony consists of studies that document the environmental factors (e.g., properties of lineup procedures) that moderate the match between past events (i.e., crimes) and current behavior (i.e., testimonies; see Busey & Loftus, 2007, for a review). A functional interpretation of memory research often requires little more than the realization that *remembering* can be conceived of as a behavioral phenomenon. Such a functional perspective also fits well with the idea that memory (i.e., remembering) can be shaped and trained in

much the same way as other behavior (e.g., Hertel, Maydon, Cottle, & Vrijsen, in press; Karpicke & Roediger, 2008).

Increased efforts to describe memory research in functional terms would reduce the use of proxies and thus help avoid the problems associated with this practice. Behavioral and other proxies of memory structures and processes are still common in the (applied) memory literature. For instance, at least initially, performance in implicit memory tasks was treated as a proxy of implicit memory (e.g., Schacter, 1987). It soon became clear, however, that performance on so-called implicit memory tasks often depends also on explicit memory. This led to the development of procedures to derive estimates of different memory processes from performance in different types of tasks (e.g., Jacoby, 1991) but also this approach has its problems and limitations (e.g., Dodson & Johnson, 1996). The likelihood of finding useful proxies for implicit memory is also reduced by conceptual and theoretical debates about what implicit memory actually entails (e.g., Butler & Berry, 2001). Although other, more recent distinctions in memory research (e.g., between verbatim and gist memory; see Reyna, Corbin, Weldon, & Brainerd, 2016) might become even more fruitful as the distinction between implicit and explicit memory, the example of implicit memory research reminds us of the risks of using proxies in memory research. Adopting a functional-cognitive framework can help reduce these risks because it encourages researchers to consistently describe phenomena in functional terms. For instance, from a functional perspective, implicit memory effects are behavioral effects of past events that occur under conditions of automaticity (see Hughes et al., 2012, for a more sophisticated functional analysis of implicit cognition). Systematically describing research on implicit memory in these terms allows researchers to study this behavioral phenomenon without adopting a priori assumptions about the mental mechanisms that underlie implicit memory (e.g., whether it involves a separate memory store or a specific

way of retrieving knowledge from a single memory store).

Developing functional definitions of the numerous phenomena that are studied in memory research could also increase coherence and cross-talk within that literature. For instance, imagine that many memory phenomena can be conceptualized as instances of remembering, that is, in terms of the impact of past events on current behavior. Different memory phenomena could then be classified with regard to the type of past environmental event, the type of current behavior, the type and properties of the organism that is involved, and the context in which the event and behavior occur (see De Houwer, Barnes-Holmes et al., 2013, for a similar analysis of learning research). [6] Undoubtedly, there will be debates about what counts as remembering (e.g., whether it makes sense to treat conscious thoughts about the past as if they are behaviors; see Hayes & Brownstein, 1986, for a discussion) and thus about how far one can take this functional analysis of memory research. Our current aim is not to settle these discussions but merely to point out that often it is possible *and* beneficial to describe memory research in functional terms.

Adopting functional descriptions of cognitive research also highlights the fact that functional researchers can contribute to memory research. For instance, Guinther and Dougher (2010, 2014) initiated a line of research in which false memories are analyzed from a functional perspective. Their studies were based on the Deese-Roediger-McDermott (Roediger & McDermott, 1995) procedure but rather than using stimuli that were pre-experimentally related, they used sets of unrelated words that were experimentally related

6 From this perspective, remembering differs from learning in that learning entails only changes in behavior that are due to regularities in the environment (e.g., stimulus pairings) whereas remembering can involve also the effect of individual stimuli at a single moment in time on subsequent behavior (De Houwer, Barnes-Holmes et al., 2013). Both learning and remembering differ from perceiving in that perceiving includes also immediate effects of environmental events on behavior whereas learning and remembering deal with the way that past environmental events moderate current behavior. This perspective implies that (a) learning always involves remembering and perceiving, (b) remembering always involves perceiving, (c) remembering does not always involve learning (i.e., when the past event is a single stimulus at a single moment in time), and (d) perceiving does not always involve learning or remembering (i.e., when only current events influence behavior).

using a procedure that is known to create classes of equivalent stimuli (i.e., stimuli that are responded to as if they are similar). Earlier research had shown that functions of one stimulus (e.g., the capacity of a stimulus to elicit fear responses) can transfer to other stimuli that were trained to be equivalent. Guinther and Dougher set out to test whether the "remembering function" of a to-be-remembered stimulus (i.e., the capacity of a stimulus to elicit recall behavior) can also transfer to other stimuli that are trained to be equivalent to that stimulus. They did this by instructed participants to remember some of the stimuli from one class. During a subsequent free recall task, they found that false memories were more frequent for stimuli that were part of the same class as the to-be-remembered stimuli than for stimuli that were part of another class. The work of Guinther and Dougher nicely illustrates how functional researchers can take phenomena that were discovered by cognitive researchers and link those to known functional principles, thus extending the functional approach in new ways. Their results are also interesting for cognitively inspired researchers because they provide new ideas about the learning history that can produce false memories and the contextual variables that moderate false memories. Hence, the work of Guinther and Dougher can provide the starting point for applied memory research that is inspired not only by cognitive theories but also by general functional principles, that is, CIAA memory research.

In sum, adopting the functional-cognitive framework in practice means that (a) research is described as much as possible in terms of environment-behavior relations and (b) that researchers seek guidance not only at the level of explanation at which they choose to operate but also at the other level.

Conclusion

In this paper, we provided a functional-cognitive perspective on the current state and possible future of applied psychology. In essence, adopting this perspective reveals unity in

diversity. Simultaneously, it clarifies how different types of applied research differ as well as what they all have in common. It does not intervene in the choice of practical problems or solutions that applied researchers study, nor does it discourage them from seeking guidance at levels of explanation other than the functional one. It does, however, highlight the common functional core of applied psychology and reveals a future in which applied psychology as a whole can be fortified by strengthening this core. Although we realize that the functional-cognitive perspective is just one of many possible perspectives on applied psychology, we hope that our paper revealed some of the potential of this perspective and will thus stimulate discussion on the current state and future of this vital part of psychological science.

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Appendix 1.

Two caveats are worth noting with regard to the claim that all applied research is functional in nature. First, although applied researchers might not strive to understand mental mechanisms for its own sake, often they do want to change mental processes. Hence, one might argue that this type of applied research is situated at the cognitive level. In many cases, however, changing mental processes is just a means to toward solving a behavioral problem (e.g., strengthening executive control in order to combat substance abuse). Although the interventions are inspired by cognitive theories, they are functional because they change the environment with the ultimate aim of changing behavior (e.g., practicing mental span tasks to reduce substance abuse; e.g., Shipstead et al., 2012). In other cases, the ultimate goal of applied researchers is to change conscious thoughts and feelings (e.g., reducing intrusive thoughts and negative feelings after a traumatic event to increase psychological wellbeing). Also these interventions can be situated at the functional level in at least two ways. First, conscious thoughts and feelings can and have been thought of as behavioral phenomena (i.e., covert behavior; see Hayes & Brownstein, 1986). Without entering into philosophical debates about the potential merits of this idea, it is therefore possible to argue that the aim to change conscious thoughts and feelings fits within a functional approach. Second, as noted above, the actual research will always be functional in nature. A researcher can influence the thoughts and feelings of another organism only by intervening in the physical environment (e.g., by producing sound waves such as spoken words that the organism can interpret). Moreover, researchers cannot directly observe changes in the conscious thoughts or feelings of other organisms but can only make inferences about those changes on the basis of overt behavior of the organism (including verbal self-reports). Hence, also when the aim is to change conscious thoughts and feelings, applied researchers are bound to the functional level,

that is, to interventions in the environment and the observation of changes in overt behavior.

As a second caveat, it is important to note that researchers can have multiple aims. For instance, researchers can sometimes strive to develop cognitive models for their own sake (i.e., cognitive research in the strict sense), while at other times develop those models in order to solve practical problems (i.e., cognitively-inspired functional research), and on still other occasions be focused only on environment-behavior relations (purely functional research). In that sense, an individual researcher can take on different roles. Nevertheless, when someone takes on the role of an applied researcher, it seems to us that he or she would look for mental mechanisms only as a means towards solving practical problems at the functional level. When a researcher only pays lip-service to the ultimate goal of solving problems, questions can be raised about whether that researcher functions as an applied researcher. Hence, when applied researchers adopt an immediate, proximal goal to uncover mental mechanisms, they need to constantly and critically evaluate whether that goal continues to serve the ultimate, distal goal of solving practical problems and need to abandon the proximal goal when there is little reason to believe that it serves the distal goal.