RUNNING HEAD: IMPLICIT PROCESSES

How to define and examine implicit processes?

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In Press. In R. Proctor & J. Capaldi, Implicit and Explicit Processes in the Psychology of Science.

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Abstract

Research on implicit processes has become increasingly popular during the past two decades. Nevertheless, relatively little attention has been given to clarifying the meaning of the concept implicit. We propose implicit processes are processes that possess features of automaticity. Because different automaticity features do not necessarily co-occur, we recommend specifying the automaticity features one has in mind when using the term implicit. We provide an overview of the definitions of the various automaticity features that are used in the cognitive decompositional approach of automaticity. Because it is difficult to diagnose the cognitive automaticity features of mental processes, we explore for the first time a functional decompositional approach to automaticity in which automaticity features are defined in non-mental terms and used to describe effects. We end by discussing the implications of our analysis for research on the role of implicit processes in scientific behavior.

Psychology as a scientific discipline is directed at understanding the processes underlying behavior. During the past two decades, more and more psychologists have become interested in the impact that so-called implicit processes have on behavior. This evolution can be seen in the various sub-disciplines of psychology, including general psychology (e.g., Schacter, 1987), social psychology (e.g., Greenwald & Banaji, 1995), clinical psychology (e.g., Gemar, Segal, Sagrati, & Kennedy, 2001), and addiction research (e.g., Wiers & Stacy, 2006). In line with this evolution, the current book addresses the topic of implicit and explicit processes in one particular aspect of human behavior, namely scientific behavior.

Despite the huge interest in implicit processes, relatively little attention has been given to the question of what it means to say that a process is implicit. In this chapter, we present an overview of the conceptual work that we have performed in this context over the past years (see De Houwer, 2006, in press; De Houwer & Moors, 2007, 2010; De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009a, 2009b; Moors & De Houwer, 2006a, 2006b, 2007; Moors, Spruyt, & De Houwer, 2010). The starting point of our analysis is the postulate that the meaning of the term implicit is identical to the meaning of the term automatic. As we will argue later on, defining implicit as automatic has the advantage that it encompasses many of the earlier, more informal definitions that have been given for the concept implicit. It also allows one to draw on the extensive conceptual work on automaticity that has been undertaken in the past.

In this chapter, we put forward the following ideas. First, automaticity is not an all-or-none property of mental processes but refers to a set of features that do not necessarily co-occur within each automatic process. Hence, it does not make sense to simply say that a process is implicit because there is no agreement about the automaticity features to which this term refers (see Bargh, 1989, 1992; Moors & De Houwer, 2006a, 2007). Second, the heterogenic nature of the concept automaticity calls for a decompositional approach in which researchers need to specify for each process which automaticity features are thought to apply to that process. This requires a precise definition of each automaticity feature. Within a cognitive decompositional approach (Bargh, 1992; Moors & De Houwer, 2006a, 2007), most automaticity features are defined in terms of mental constructs such as goals, consciousness, and processing resources. Hence, when using the term *implicit*, one should specify in a precise manner the automaticity features one has in mind (i.e., De Houwer, 2006; De Houwer et al., 2009a). Third, claims about automaticity features need to be backed up with sound arguments and empirical evidence. Hence, when claiming that a process is implicit in a certain manner, one should be able to justify these claims (De Houwer et al., 2009a, 2009b). Fourth, obtaining evidence for the automaticity of mental processes is complex (see Moors et al., 2010). Hence, studying the implicit nature of mental processes can run into important problems. Finally, we introduce the idea that progress in understanding the nature of implicit processes can be facilitated by a functional decompositional approach to automaticity (De Houwer, in press). This approach entails that automaticity features are defined strictly in terms of observable elements in the environment rather than unobservable mental constructs. In addition, the primary aim is to examine the automaticity features of effects (i.e., the causal impact of elements in the environment on behavior). Knowledge about the automaticity of effect, however, can be used to guide the construction of models about the mental processes by which elements in the environment influence behavior (see De Houwer, in press). We end the paper by illustrating the implications of our analysis for future research on implicit processes underlying scientific behavior.

Automaticity is not an all-or-none feature

According to the dual-mode or all-or-none view on automaticity, processes are either automatic or non-automatic. Automatic processes are assumed to have all automaticity features; non-automatic processes have the opposite features. For instance, all automatic processes are assumed to be unintentional, uncontrolled, unconscious, efficient, and fast whereas all non-automatic processes are assumed to be intentional, controlled, conscious, inefficient, and slow. According to this view, it is relatively easy to diagnose a process as automatic. It suffices to demonstrate that the process possesses one of the automaticity features. If it has one of the features, it can be assumed to have all other automaticity feature and thus to be fully automatic.

It became clear, however, that the different automaticity features do not always co-occur. Evidence from Stroop studies, for instance, suggests that the processing of word meaning is automatic in that it does not depend on the intention to process the meaning of the word. At the same time, word processing is non-automatic in that it depends on the allocation of attention to the word (see Bargh, 1989, 1992, 1994, and Logan, 1985, 1989, for a discussion of this evidence). Several reasons can be identified for why the all-or-none view on automaticity remained popular despite the evidence against it (see Moors & De Houwer, 2007, for a discussion). Nevertheless, there can be little doubt about the fact that this view is incorrect.

Given the assumption that the concepts automatic and implicit can be used in an interchangeable manner, one can conclude that it makes little sense to simply say that a process is implicit. This means little more than saying that a process possesses one or more features of automaticity, leaving it unspecified which automaticity features apply. Hence, when using the term implicit, it is best to always make explicit the automaticity features one refers. Such an approach can be called decompositional in that the concepts implicit and automatic are actually decomposed into various non-overlapping features. However, a decompositional approach is meaningful only if one can clearly define the different automaticity features in a non-overlapping way. In the next section, we discuss the cognitive decompositional approach that does incorporate detailed definitions of these features.

The cognitive decompositional approach to automaticity

Within this section, we first provide an overview of the definitions of automaticity features as put forward by Moors and De Houwer (2006a, 2007). The main purpose of this overview is to show that detailed, non-overlapping definitions of automaticity features can and have been formulated. Researchers who want to make explicit their ideas about the implicit nature of processes can thus draw upon these definitions. Next we discuss whether the cognitive decompositional approach allows one to encompass the different definitions that have been given in the past for the concept implicit. Finally, we examine the problems that can arise when diagnosing whether a process possesses certain automaticity features.

Defining automaticity features

Many automaticity features such as (un)intentional, goal-directed, goal-(in)dependent, (un)controlled/(un)controllable, and autonomous, are somehow related to goals. Perhaps the most central goal-related automaticity feature is the feature uncontrolled. Uncontrolled is the opposite of controlled. We therefore start with a definition of controlled. To say that a process is controlled implies a proximal goal (i.e., a goal regarding the target process such as the goal to engage in, alter, stop, or avoid the process) that causes the achievement of the end state put forward in the goal (i.e., the actual occurrence, change, interruption, or prevention of the process). To say that a process is uncontrolled can therefore have different meanings. It can refer to the fact that the state of a process changes (i.e., that the process occurs, changes, is interrupted, or prevented) in the absence of a goal to achieve this change. It can also refer to the fact that the goal is present but the desired effect is absent. For instance, a process can be called uncontrolled when the process occurs despite the goal to prevent the occurrence of the process. A process can also be described as uncontrolled when both the goal and the desired effect are present, but the effect was not caused by the goal. Imagine that you have the goal to kneel down in front of your loved one in order to propose marriage. You do kneel down but it happens because someone pushes you. In that case, both the goal and the desired effect are present, but it would be wrong to regard the act of kneeling down as controlled because the goal did not cause the desired effect.

Other goal-related automaticity features can be defined in terms of the feature uncontrolled. To say that a process is intentional means that the goal to engage in a process causes the occurrence of the process. Hence, intentional is identical to controlled in the sense of the goal to engage in (rather than the goal to alter, stop, or avoid the process). Therefore, unintentional processes are a subset of uncontrolled processes. A process can be termed unintentional because the process occurs without the intention to engage in the process or because the goal to engage does not cause the occurrence of the process. The feature autonomous can be defined as uncontrolled in terms of every possible processing goal. That is, an autonomous process is a process that is uncontrolled in every possible sense. Goal-independent processes are processes that operate independently from proximal goals (i.e., goals relating to the target process such as the goal to start, stop, alter, or avoid the process) and distal goals (i.e., goals unrelated to the target process). Therefore, a process might be uncontrolled but still be goal-dependent. Finally, processes can be described as purely stimulus-driven when in addition to being goal-independent (i.e., not dependent on any type of goal), they also do not depend on other factors such as awareness or attention. The occurrence of purely stimulus-driven processes depends only on the presence of a stimulus and certain basic conditions which ensure that the stimulus can be physically registered (e.g., in the case of visual stimuli, that the eyes are not closed).

The feature unconscious is often listed as a core feature of automaticity. Unfortunately, (un)consciousness as a mental state is notoriously difficult to define (see Moors & De Houwer, 2006a, for an analysis). This limits its usefulness as a defining feature of automaticity. It is also important to realize that the term unconscious can be used as a predicate of several things. It can refer to (a) the stimulus input that evokes the process, (b) the output of the process, (c) the process itself, or (d) the consequences of the process such as its influence on subsequent processing (e.g., Bargh, 1994). Therefore, when using the term unconscious, it is important to specify what it is a predicate of. Note that there is no complete overlap between the feature (un)conscious and goal-related features. For instance, our definitions allow for the possibility of unconscious intentional processes, that is, a process that occurs only when there is a goal to engage in the process but that can operate in the absence of awareness of the process, its input, output, or consequences.

A process can also be automatic in the sense of efficient. Efficient processes can be defined as processes that consume few processing resources or attentional capacity. Because efficiency leads to the subjective experience that processing is effortless, the terms efficient and effortless are often used interchangeably. Again there is no complete overlap between efficiency and other automaticity features. Whereas goals are related to the *direction* of attention (goals may determine the focus of attention), efficiency is related to the *amount* of attention. We also allow for the possibility of a state of consciousness that exists outside of attention and thus for efficient conscious processes (Block, 1995). Likewise, in principle, processes can be unconscious but non-efficient (e.g., Naccache, Blandin, & Dehaene, 2002).

Finally, processes can be automatic in the sense of fast. The feature fast refers to the time that is needed for a process to run to completion. This feature is clearly a gradual feature. There is no objective threshold for calling something fast or slow, so investigators need to rely on common sense arguments for calling some interval short or long or for deciding whether a process is fast or slow. Processes that are fast also tend to be uncontrolled (because the implementation of goals tends to require time), unaware (because consciousness needs time to develop), and efficient (because efficient processes are typically faster than non-efficient processes). Nevertheless, this overlap is only partial in that some uncontrolled, unconscious, or efficient processes might be slow and some controlled, conscious, or inefficient processes might be fast.

Describing implicit processes in terms of automaticity features

In the past, researchers have described processes as being implicit because they operate in an unintentional, uncontrolled, efficient, fast, or unconscious manner. Our definition of implicit as automatic, in combination with a decompositional approach of automaticity allows us to encompass many if not all of the previous definitions of implicit processes. The decompositional approach also clarifies that researchers need to make explicit the automaticity feature that they have in mind when using the concept implicit and it provides them with the conceptual tools to precisely describe their definition of the crucial automaticity features. Hence, we hope that our analysis of the concepts implicit and automatic will improve communication amongst researchers when they study implicit processes.

We do not commit ourselves to one particular automaticity feature as being the crucial feature for diagnosing whether a process is implicit. Others have put forward one specific feature such as the feature unintentional (e.g., Fazio & Olson, 2003; Richardson-Klavehn, Lee, Joubran, & Bjork, 1994) or the feature unconscious (e.g., Schacter, 1987) as the one feature that determines whether a process qualifies as implicit. In our opinion, the selection of a particular feature or set of features as central for implicit processes cannot be settled on the basis of a priori arguments but needs to be decided on the basis of empirical data. The distinction between implicit and explicit processes is functional only if it allow us to increase our understanding of (the processes underlying) behavior. If behavior is not differentially affected by whether the underlying process possesses a particular automaticity feature, then there is little added value in distinguishing between implicit and explicit processes on the basis of that automaticity feature. Hence, the concept implicit should be linked to the features that actually matter for behavior. For instance, research on implicit memory has shown that the conscious or unconscious nature of memory retrieval is relatively unrelated to the way in which variables influence memory retrieval (e.g., the impact of level of processing during encoding). What does seem to matter is whether retrieval is intentional (see Richardson-Klavehn et al., 1994). This suggests to us that it is more functional to define implicit memory in terms of the feature unintentional than in terms of the feature unconscious. It remains to be seen, however, whether these results generalize to processes other than memory retrieval. Until sufficient data are available for selecting one automaticity feature as central for the concept implicit, we prefer a broad definition of implicit as automatic covering several automaticity features. Of course, the selected features need to be made explicit and defined in an unambiguous manner.

One could, however, argue that such a broad definition is problematic (e.g., Nosek &

Greenwald, 2009). First, defining implicit as automatic and explicit as non-automatic might blur the distinction between implicit and explicit processes. We agree that most processes are probably automatic (and thus implicit) in some ways and non-automatic (and thus explicit) in other ways. This does indeed blur the distinction. However, at present we believe that defining implicit as automatic and explicit as non-automatic is the best available alternative. As indicated above, one could select one automaticity feature as the criterion that provides the dividing line, but it is not clear which criterion should be selected or whether it will ever be possible to reach consensus about the to-be-selected criterion. Hence, for now it is best not to commit to one feature but to adopt a broad definition that allows each researcher to make explicit the specific feature that they have in mind.

Difficulties with examining the automaticity features of mental processes

Although our definition of implicit does allow researchers to specify in great detail the conceptualization that they have in mind, even conceptually precise claims about the implicit nature of processes have little value when these claims cannot be backed up by valid arguments and empirical evidence. Therefore, claiming that a process is implicit not only requires precision but also justification. Unfortunately, several important challenges need to be overcome in order to obtain empirical evidence for automaticity features of mental processes. In this section, we provide a brief overview of these challenges (for more details, see De Houwer, in press; De Houwer, Gawronski, & Barnes-Holmes, 2010; Moors et al., 2010).

Each automaticity feature refers to a certain set of conditions. For instance, the feature unintentional refers to a situation in which the goal to initiate a process is absent. A process is said to possess a certain automaticity feature if it operates under the set of conditions specified by the automaticity feature. For instance, the process qualifies as unintentional if it operates in the absence of the goal to initiate that process. Therefore, in order to examine the automaticity features of a mental process, the following steps need to be taken: First, it needs to be established that the set of conditions that is specified by a feature, is actually present (e.g., that a person does not have the goal to initiate the process). Second, one should be able to ascertain that the process operates under those conditions.

When adopting a cognitive decompositional approach, both steps are complicated by the fact that mental constructs cannot be observed directly (see De Houwer, in press; De Houwer et al., 2010). First, several automaticity features refer to the presence or absence of unobservable mental constructs. For instance, goal-related features refer to goals. Likewise, the feature efficient refers to the construct of mental resources. Goals and mental resources cannot be observed directly. One can at best infer their presence on the basis of observable elements in the environment or observable behavior (e.g., task instructions or performance on a secondary task) but such inferences depend on assumptions that might not always hold (e.g., that participants follow instructions or that a secondary task loads the same resources as the primary task).

Second, many of the mental processes that are studied by cognitive psychologists (e.g., the formation of associations in memory, the activation of nodes and associations in semantic networks, working memory, and reasoning) cannot be observed directly. Consider the process of attitude activation (see Moors et al., 2010, for a more detailed discussion of this example). Attitudes can be conceived of as mental representations that specify a positive or negative disposition toward a certain object (e.g., Eagly & Chaiken, 2007). Unfortunately, attitudes (e.g., toward science) cannot be observed directly. Researchers have therefore developed tasks that provide measures of attitudes. One of these measures is affective priming (Fazio, Sanbonmatsu, Powell, & Kardes, 1986; see De Houwer et al., 2009a, for a review). Affective priming refers to the observation that responses to a target stimulus (e.g., HAPPY) are faster when it is preceded by a prime stimulus with the same affective valence (e.g., SUMMER) than when the prime stimulus has a different valence (e.g., CANCER). Because affective priming can occur only if the attitude toward the prime stimulus has been activated, the observation of affective priming allows one to conclude that attitude activation has taken place. The automaticity of attitude activation can be examined by examining the conditions under which affective priming occurs. For instance, if affective priming occurs even when participants do not have the goal to retrieve their attitudes towards the prime stimuli, one can conclude that attitude activation was unintentional.

There are, however, limitations to the extent to which the automaticity features of mental processes such as attitude activation can be inferred. First, although the presence of an observable effect (e.g., affective priming) allows one to infer the presence of certain mental processes (e.g., attitude activation), the absence or change in the size of the effect does not allow one to infer the absence of or change in the operation of a particular mental process. Affective priming, for instance, depends not only on the activation of the attitude towards the prime but also on other processes by which the activation of the prime attitude influences responses to the target (e.g., spreading of activation or response activation; see De Houwer et al., 2009a, for a review). Therefore, if affective priming is absent under the conditions specified by a particular automaticity feature (e.g., when participants do not direct attentional resources to the prime; e.g., Hermans, Crombez, & Eelen, 2000; but see Degner, 2009), this does not mean that attitude activation does not possess that automaticity feature (see Gawronski, Deutsch, LeBel, & Peters, 2008, and Moors et al., 2010, for a detailed discussion of this issue). More generally, because observable behavior is often (if not always) determined by multiple mental processes, it is difficult to draw strong conclusions about a single process based on the absence of or change in a particular behavior.

A second limitation is that even the presence of a behavioral effect informs us only about mental processes that are conceptualized at the functional level. Marr (1982) pointed out that mental processes can be described at three levels: The functional, algorithmic, and implementational level. Functional descriptions of mental processes specify what the processes do, that is, which inputs are transformed into which outputs. For instance, at the functional level, attitude activation can be described as (a necessary part of) the mental process by which stimuli in the environment cause evaluative responses (see De Houwer et al., 2010). The algorithmic level deals with a symbolic description of the way in which the mental process achieves this function. For instance, attitude activation can be attributed to the activation of evaluative nodes in a semantic network (e.g., Fazio, 2007). Finally, the implementation level refers to how the mental process can be physically instantiated, for instance, in a (simulated) human brain.

Importantly, there is a many-to-one relation between the algorithmic descriptions and functional descriptions. For instance, the functional process of attitude activation can be conceived of at the algorithmic level not only as involving the activation of evaluative nodes in a semantic network (e.g., Fazio, 2007) but also in terms of the retrieval of separate episodic memory traces (e.g., Schwarz, 2007). Therefore, although the presence of a behavioral effect (e.g., affective priming) allows for conclusions about the automaticity of functional mental processes (e.g., attitude activation), it does not allow for strong conclusions about the automaticity of algorithmic mental processes (e.g., activation of nodes in a semantic network). For instance, the conclusion that affective priming can occur in the absence of the goal to process the prime does not allow for strong conclusions about whether evaluative nodes can be activated automatically in a semantic network (see Moors et al., 2010, for more details).

Summary

The cognitive decompositional approach has been elaborated in detail at the conceptual level (Moors & De Houwer, 2006a, 2007) and can help researchers to specify their conceptualization of the term implicit. Unfortunately, problems arise when studying the automaticity features of mental processes empirically. These problems result from the fact that automaticity features are defined in terms of mental constructs and the fact that researchers often aim to determine the automaticity features of (algorithmic) mental processes. In the next section, we therefore explore the possibility of developing a decompositional approach to automaticity that does not refer to mental constructs.

Toward a functional decompositional approach to automaticity

De Houwer (in press) recently proposed a functional-cognitive framework for psychological research that allows for a functional decompositional approach to automaticity. Within this approach, automaticity features are defined not in terms of mental constructs but in terms of observable elements of the environment. Although the functional decompositional approach is primarily directed at describing the automaticity of effects, it can also shed light on the nature of the mental processes that underlie behavior. We start this section by briefly explaining the functional-cognitive framework. Afterwards, we provide some preliminary ideas about how automaticity features might be defined in a functional, non-mental manner. Next, we explore for the first time how research on implicit processes might benefit from the functional decompositional approach to automaticity.

The functional-cognitive framework for psychological research

De Houwer (in press) argued that psychological research can have two aims. The first aim is to describe which elements of the observable environment influence behavior under which conditions. Within the psychology of science, for instance, the first aim would entail the discovery of those elements in the environment that determine scientific behavior. Examples of such determinants are science education, pictures of famous scientists, and rewards that are contingent upon scientific behavior. This first approach can be described as functional in that it focuses only on discovering effects (i.e., the causal impact of the environment on behavior) and the elements in the environment that moderate these effects. The second aim is to describe the mental processes by which elements in the environment influence behavior. For instance, once it has been verified that science education has an effect on scientific behavior under certain conditions, cognitive theories can be constructed about the mental representations that are formed as the result of science education (e.g., positive attitudes toward science) and how those representations promote scientific behavior. This is the aim of the cognitive approach in psychology.

Importantly, the functional and cognitive approaches are mutually supportive (see De Houwer, in press). Functional knowledge (i.e., knowledge about the moderators of effects) imposes constraints on ideas about the mental processes by which the environment influences behavior. Therefore, the more we know about the impact of the environment on behavior, the better we are able to formulate ideas about the underlying mental processes. The development of functional knowledge can in turn benefit from the existence of strong cognitive theories because those theories can reveal links between existing pieces of functional knowledge (i.e., the heuristic function of theories) and can lead to predictions about yet unknown functional relations (i.e., the predictive function of theories).

A decompositional approach to automaticity can be developed within the functional approach. The functional approach aims to identify the moderators of effects, that is, the environmental conditions under which certain elements of the environment (e.g., science education) influence behavior (e.g., performance on scientific tasks). When automaticity features are defined in terms of environmental conditions, they can thus be regarded as a subset of all moderators of effects. Hence, a functional decompositional approach of automaticity entails that effects are characterized in terms of whether they occur under the environmental conditions that are specified by the various automaticity features. It differs from a cognitive decompositional approach in that (a) automaticity features are described only in terms of observable elements in the environment (and not mental constructs) and (b) automaticity features are used in first instance to characterize effects rather than mental processes. Because research on the automaticity of effects increases functional knowledge of those effects, it constraints the development of cognitive theories and thus contributes also to our understanding of the mental processes that underlie behavior. In the following sections, we explore for the first time whether a functional decompositional approach can be developed conceptually (i.e., whether automaticity features can be defined in terms of environmental conditions) and what its possible merits might be.

Defining automaticity features in non-mental terms

Within the cognitive decompositional approach, the feature *fast* was already defined in terms of environmental conditions, more specifically, in terms of the length of time. Effects can be described as fast when they occur even though little time elapses between the presence of the environmental cause (e.g., the prime in an affective priming study) and the observed behavior (e.g., the response to the target).

Other features might be re-conceptualized in non-mental terms. The label efficient, for instance, could be used to describe effects that occur even in the presence of other demanding tasks. Let us return to the example of affective priming effects (i.e., the impact of a prime on responses to a target with the same or a different valence as the prime). The fact that affective priming effects can occur while participants memorize complex digits (e.g., Hermans et al., 2000, but see Degner, 2009) can be taken as evidence for the efficient nature of the affective priming effect. Of course, one should also be able to define the nature of demanding tasks without referring to mental constructs. One possibility is to define the difficulty of a task in terms of the quality of task performance (e.g., speed and accuracy) under certain conditions. The task itself can be conceptualized as a set of operant contingencies that is present in the environment (i.e., regularities between responses and outcomes of those responses that occur under certain conditions).

Re-conceptualizing goal-related features and (un)consciousness might be more difficult. The names of features such as unintentional, goal-independent, and unconscious intrinsically refer to mental constructs (i.e., intentions, goals, and consciousness). It would thus be difficult to re-define these terms in non-mental terms (but see Hayes, Barnes-Holmes, & Roche, 2001, for suggestions on how mental concepts could be rephrased in functional, non-mental terms). An alternative is to introduce new labels that do not refer to mental constructs but that capture the environmental conditions associated with cognitive automaticity features. For instance, effects could be described as task-independent (rather than goal-dependent) if they occur regardless of the presence of other tasks in the environment. Uncontrolled effects can be relabeled as proximal task-independent effects, that is, effects that occur regardless of the presence of tasks related to the effect. For instance, affective priming can be described as proximal task-independent when the effect occurs even if participants are instructed not to show the effect. Finally, effects can be described as non-reportable (rather than unaware) when participants cannot recognize the effect of the environmental cause on their behavior. Of course, much more conceptual work is needed before the functional decompositional approach can be considered as a viable alternative for the cognitive decompositional approach. In the next section, we argue that there are enough potential benefits to justify the further development of the functional decompositional approach.

Merits of the functional decompositional approach to automaticity

In what ways can the functional decompositional approach to automaticity help researchers who would like to study the implicit processes that underlie behavior? First, whereas the cognitive decompositional approach focuses on the implicit nature of mental processes, the functional decompositional approach highlights the fact that also effects can qualify as implicit. Within the functional decompositional approach, automaticity features are a subset of all possible environmental moderators of effects. Understanding the (automaticity-related) moderators of effects is important as such because it reveals the nature of the relation between the environment and behavior and thus helps us to understand, predict, and control human behavior (see De Houwer, in press; Hayes & Brownstein, 1986). For instance, assume that future research will show that science education reduces the probability that people will turn to alternative medical practices. Knowing that this effect occurs allows one to reduce the extent to which people call upon alternative medicine by making science education available in schools. If research also shows that the effect of science education on the use of alternative medicine is non-reportable (i.e., the effect occurs regardless of whether people recognize the effect when asked about it), this would suggest that there is no need to draw attention to the link between science education and alternative medicine in order to expect a relation between both. In sum, functional research - including research on the implicitness of effects - has merits as such.

Second, empirical research on the implicit nature of effects is faced with fewer problems than empirical research on the implicitness of mental processes. First of all, functional automaticity features are defined in terms of observable environmental conditions and are thus easier to establish that cognitive automaticity features that are defined in terms of unobservable mental constructs. Moreover, the presence of effects is typically easier to verify than the presence of mental processes. Establishing the presence of an effect entails that a particular change in behavior (e.g., fast responses to a target) is causally attributed to an element in the environment (e.g., the presence of a certain prime). Although causal relations cannot be observed directly, experimental procedures allow one to implement the controls necessary for drawing causal conclusions with great confidence.

Third, because of the mutually supportive nature of the functional and cognitive approaches, improvement in functional knowledge can improve theories about the mental processes that underlie behavior (see De Houwer, in press, for a detailed justification of this claim). Knowledge about the functional automaticity features that apply to a certain effect, imposes important constraints on the nature of the algorithmic mental processes that are assumed to underlie the effect. As such, research on the implicitness of effects can promote the development of cognitive theories about the implicit mental processes that underlie behavior.

Whether the functional decompositional approach will actually turn out to be valuable for research on implicit processes of course remains to be seen. We have introduced only the basics of the approach and much still remains to be done. Nevertheless, we hope to have provided the starting point for these future developments.

Implications for the study of scientific behavior

Based on the analysis presented above, the following general guidelines can be formulated for researchers who aim to study implicit processes in scientific behavior. First, specify the automaticity features that you want to refer to when using the term implicit. It does not make sense to simply say that a process or effect is implicit because there is no single class of automatic processes that all have the same set of automaticity features. Although an all-or-none view of automaticity is appealing because of its simplicity, empirical evidence shows that different processes can have different features of automaticity. Specifying one's conceptualization of implicit not only requires the selection of certain automaticity features but also a precise definition of those automaticity features. Our earlier work (Moors & De Houwer, 2006a, 2007) provides the basis for defining these features in a cognitive manner. In the present chapter, we also discussed ways of defining automaticity features in a functional manner.

Second, the claim that a mental process or effect is automatic in a certain sense is actually a claim about the conditions under which the process or effect occurs. Hence, these claims make sense only when they can be backed up by sound arguments and evidence. It is important to realize that claims about cognitive automaticity features of mental processes are not easy to back up. In the future, a functional decompositional approach could provide a more workable alternative. Even in its current state of development, the functional approach highlights the fact that one can describe as implicit or explicit not only mental processes but also effects. The study of the implicit nature of effects can have merits as such and help develop theories of the implicit nature of mental processes.

To illustrate these guidelines, we will relate them to the chapter of Zimmerman and Pretz (this volume) about implicit and explicit processing in scientific discovery. They asked one group of participants to solve a real-world physics task by looking for a rule. Other participants were not given this instruction or asked not to think too hard while performing the task. Zimmerman and Pretz referred to the first group as the explicit processing group, whereas the second group was referred to as the implicit processing group. With regard to our first guideline (i.e., specify the meaning of implicit), they describe dual-process theories that make a distinction between implicit and explicit modes of processing (e.g., Evans, 2008; Sloman, 1996). The explicit mode is characterized as rule-based, deliberate, and analytical and as dependent on awareness, attention, and effort. Implicit processing is described as associative, holistic, unaware, and effortless. However, it is not specified whether these definitions of implicit and explicit were assumed to hold also for the type of processing that was encouraged in their own research. Moreover, their definitions of implicit and explicit are based on an all-or-none view of automaticity rather than the decompositional approach (e.g., Bargh, 1994; see Keren & Schul, 2009, and Moors & De Houwer, 2006b, for a critical discussion of dual-process theories).

With regard to the second guideline (i.e., justify the meaning of implicit), participants were said to have adopted an implicit processing mode when they were not given any specific instructions on how to approach the task (Experiment 1) or when they were instructed not to think too much about the task (Experiments 2 and 3). These instructions could indeed have led to absence of the goal to discover a rule. Processing could thus be described as implicit in the sense of independent of the distal goal to solve the problem by finding a rule. However, processing was in all likelihood explicit in many other ways. For instance, all participants had the goal to make correct predictions on each trial. Hence, processing was probably deliberative (i.e., intentional in the sense of dependent on the proximal goal to perform well in the task). Also, participants in the so-called implicit conditions were probably aware of the stimuli that were presented and the responses that they gave. They might have been unaware of the reasons for their predictions, but Zimmerman and Pretz provide no data to verify this. Furthermore, it is possible that (some) participants in the implicit condition did use an intentional strategy to solve the problems (i.e., adopted the goal to solve the task in a certain manner), be it a strategy other than looking for a rule (e.g., responding based on similarity with previous problems). There are also no data about whether performance in the implicit conditions was effortless (e.g., no evidence that performance did not deteriorate as the result of secondary tasks). Participants gave their predictions more quickly in the implicit conditions than in the explicit conditions, but in both conditions, reaction times were longer than two seconds, leaving enough time to allow for slow acting processes.

In sum, the data of Zimmerman and Pretz support the important conclusion that the quality of scientific problem solving can sometimes benefit from a processing mode that can be described as implicit in the sense of operating in the absence of the goal to finding a rule. We do not exclude the fact that scientific problem solving can benefit from processes that are implicit in other senses (e.g., unaware or effortless), but the evidence provided by Zimmerman and Pretz does not allow for such a conclusion. The fact that Zimmerman and Pretz adopted a broad, all-or-none definition of the concept implicit conceals the true contribution of their work and could create the impression that their results generalize to other processes with other automaticity features. We hope that this example illustrates how our analysis can contribute to research on the role of implicit processes in scientific behavior.

Conclusion

The distinction between implicit and explicit processes has become a hot topic in psychological research. Unfortunately, this distinction is more complex than is often assumed. At the conceptual level, it is best not to think of the relation between implicit and explicit processes as an all-or-none distinction between, on the one hand, processes that have all automaticity features and, on the other hand, processes that do not have any automaticity features. Because different processes can possess different features of automaticity, one should specify the automaticity features one has in mind when using the term implicit. At the empirical level, important problems can arise when trying to back up claims about the automaticity features under study. This is especially the case when automaticity features are defined in terms of mental constructs such as goals and used to describe mental processes. We explored for the first time the possible merits of a functional decompositional approach to automaticity that tries to solve some of these problems. Nevertheless, it should be clear that research on implicit processes can be very complex. One reaction is to simply ignore the complexity by continuing to conceptualize implicitness in an all-or-none manner. Although this strategy certainly simplifies matters, it is bound to create problems in the long run, for instance, when confronted with evidence for automaticity features that do not co-occur. One can also choose to ignore the concept implicit and abandon research on implicit processes all together. Such an approach runs the risk of missing out on important knowledge about the determinants of human behavior. For us the most meaningful strategy is to acknowledge the complexity and to try to deal with it in the best way possible. We hope that despite of its complexity, researchers will also adopt this strategy when studying scientific behavior.

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