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Automaticity

Agnes Moors

Ghent University, Department of Psychology

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Abstract

This chapter discusses two classes of views of automaticity: mechanism-based views and feature-based views. For each view it is considered what the implications are for the diagnosis of a process or behavior as automatic. The class of feature-based views is discussed in further detail. First, definitions of features are listed. Then, it is proposed that features provide information about operating conditions. This broadens the scope toward examining operating conditions that are not included in the automaticity concept. Finally, various feature-based views are examined that differ with regard to the amount of coherence that they assume among features.

Key Words:

automatic, uncontrolled, unintentional, goal -independent, unconscious, efficient, fast, purely stimulus driven

Introduction

The concept of automaticity is important across nearly all subareas of psychology. Pertinent questions are as follows: What is automaticity? What is automatization? How can one diagnose whether a process or behavior is automatic? I discuss two classes of views of automaticity and automatization: mechanism-based views and feature-based views. The class of feature-based

views is discussed in further detail. First, I present definitions of features, in which the central ingredients of these features (goals, attention, consciousness, and duration) are specified. Then, I submit the proposal that features provide information about operating conditions. This broadens the scope toward examining operating conditions with ingredients that are not included in the automaticity concept (e.g., stimulus intensity). Finally, I examine various feature-based views that differ with regard to the amount of coherence that they assume among features or operating conditions. I advocate a decompositional view that argues for the separate investigation of automaticity features. Research about ingredients (goals, attention, consciousness, duration, stimulus intensity) has revealed that the relations among these ingredients are complex. This complexity, however, does not seem to have infused many researcher's' usage of automaticity. The present chapter tries to connect the dots. Ideally, recent (and future) insights in the relations between ingredients of automaticity features should inform researcher's' usage of the term *automaticity*.

Before embarking on a discussion of views of automaticity, I wish to specify that the term *automatic* can be a predicate of processes or behaviour. It may be good to keep in mind that processes can be described at different levels of analysis. Marr (1982), for example, distinguished between three levels of analysis. The first, functional level articulates the functional relation between input and output (i.e., what the process does). The second, algorithmic level specifies the mechanisms involved in transforming input into output as well as the format of the representations (i.e., codes) on which the mechanisms operate. Examples of mechanisms are the activation of associations, rule-based computation, and information integration (Hélie, Waldschmidt, & Ashby, 2010). Examples of codes are propositional, conceptual, and perceptual codes. The third, implementational level is concerned with the physical implementation of processes in the brain. Processes described at higher levels of analysis can be explained by

processes described at lower levels of analysis. This type of explanation has been called a vertical or synchronic explanation, and it has been contrasted with a horizontal, diachronic, or causal explanation (Crisp & Warfield, 2001).

Views and Diagnosis of Automaticity

Views of automaticity can be divided into two classes: mechanism-based views and feature-based views. Mechanism-based views define automaticity in terms of a particular mechanism. Feature-based views define automaticity as an umbrella term for a number of features such as uncontrolled, unconscious, efficient, and fast. I discuss one mechanism-based view and several feature- based views. I discuss the implications of each view for the diagnosis of a process or behaviour as automatic and highlight their strengths and weaknesses.

Mechanism-Based View

According to a mechanism-based view, a process or behavior described at the functional level of analysis is automatic when it can be explained by one particular mechanism at the algorithmic level. The best-known example of a mechanism-based view is that of Logan (1988). He proposed to define automaticity in terms of the mechanism of direct memory retrieval (i.e., associative mechanism). A process described at the functional level is automatic when it can be explained by direct memory retrieval at the algorithmic level. Logan defined automatization or the development toward automaticity as the transition from a computation of a complex procedure (i.e., rule-based mechanism) toward direct memory retrieval (i.e., associative mechanism). To solve arithmetic problems of the type “5+3+2=?,” participants initially engage in a complex procedure that consists of two steps. In a first step, they retrieve the sum of 5 and 3, which leads to the intermediate outcome 8. In a next step, they retrieve the sum of 8 and 2, which leads to the

final outcome 10. Once an association is formed between the set of digits and their sum, participants are able to directly produce the sum by activating this association.

The mechanism-based view proposes to diagnose a process as automatic when the underlying mechanism is an associative mechanism. It is notoriously difficult to determine whether a (high-level) process is based on an associative or a rule-based mechanism (cf., Hahn & Chater, 1998; Moors, in press; Moors & De Houwer, 2006b). The criterion for diagnosing a (high-level) process as automatic or nonautomatic is therefore difficult to apply.

Logan's (1988) view is incompatible with the view espoused by Anderson (1992) and Rosenbloom and Newell (1986) that automatization can be defined as the strengthening of procedures (i.e., a rule-based mechanism). These authors do not portray automatization as a shift from one type of mechanism to another, but rather as a change in the same underlying mechanism, the strengthening of procedures. Processes have the same underlying mechanism in the nonautomatic stage as in the automatic stage, but in the latter stage, the mechanism is executed faster and more efficiently. Hence, automatic and nonautomatic processes and behavior only differ with regard to the features (fast, efficient) they possess. In other words, these authors advocate a feature-based view of automaticity. Logan's view is also incompatible with a reconciling approach (e.g., Tzelgov, Henik, Sneg, & Baruch, 1996; Tzelgov, Yehene, Kotler, & Alon, 2000) in which it is argued that both mechanisms of procedure strengthening and a shift toward direct memory retrieval are equivalent mechanisms underlying automatization. Advocates of the reconciling view also define automaticity in terms of features.

In sum, Logan (1988) proposed a mechanism-based views in which automaticity is defined in terms of the underlying mechanism of direct memory retrieval. Partisans of the procedure-strengthening view and the reconciling view of automatization found this proposal to be unsatisfactory because it cannot integrate findings supporting the automatic nature of other

mechanisms than direct memory retrieval (Carlson & Lundy, 1992; Hélie et al., 2010; Kramer, Strayer, & Buckley, 1990; Moors, De Houwer, & Eelen, 2004; Schneider & Fisk, 1984; Smith & Lerner, 1986; Tzelgov, Yehene, Kotler, & Alon et al., 2000; Van Opstal, Moors, Fias, & Verguts, 2008). Of course, according to the mechanism-based view, these findings do not count as evidence for automaticity. The main reason to reject the mechanism-based view is precisely that it excludes certain (low-level) processes from the realm of automatic processes on an a priori basis. The question of which mechanisms can underlie automatic processes and behaviour should be open to empirical study. It should not be answered a priori that only one mechanism can be automatic. The alternative option is to define automaticity in terms of features. I now turn to a discussion of feature-based views.

Feature-Based Views

This section starts with definitions of the most current features of automaticity (for an extended justification of these definitions, see Moors & De Houwer, 2006a; Moors & De Houwer, 2007). The field is marked by the absence of explicit definitions of automaticity features and the inconsistent use of implicit definitions of these features. The definitions that I present are stipulative in nature, yet their choice is guided by three principles.: I chose definitions (a) that are in line with dominant philosophical writings, (b) that remain close to natural language, and (c) that have minimal mutual overlap.

Definitions of Features

I define the following features of (non)automaticity: (un)controlled, (un)intentional, (non)autonomous, goal (in)dependent, (un)conscious, (non)efficient, fast(slow), and (not) purely stimulus driven. For each of the features, I identify the (central) ingredients. I also specify what the features can be a predicate of. Features can be predicates of processes described at high

(functional) or low (algorithmic) levels of analysis. All features can be predicates of entire processes, and some features can be predicates of parts of processes. Examples of parts are inputs and outputs of processes, at least when processes are defined at a high level of analysis as relations between an input and an output. I start with the features (un)controlled, (un)intentional, (non)autonomous, and goal (in)dependent. The central ingredient of these features is a goal (or the absence of a goal). I therefore call them goal-related features.

(Un)controlled

A process is controlled when a person has a goal[1] about the process and this goal causes the desired effect (the state represented in the goal). This definition has three ingredients: a goal about a process, an effect, and a causal relation between goal and effect. Processing goals can be of the promoting type (i.e., the goal to engage in the process) or of the counteracting type (e.g., the goals to alter, stop, or avoid the process). In the case of a promoting goal, the desired effect is the actual occurrence of a process. In the case of a counteracting goal, the desired effect is a change, the interruption, or the prevention of a process.

A process is uncontrolled when one or more ingredients (the effect, the goal, or the causal relation) are missing. A process is uncontrolled when a person has a goal about the process, but the desired effect is absent. A process is also uncontrolled when the goal about the process is absent but an effect is present (i.e., the process occurs, changes, is interrupted, is prevented). For example, a process is uncontrolled when it is prevented despite the fact that the person did not have the goal to prevent it. Something else caused the prevention. Finally, a process is uncontrolled when both the goal and the desired effect are present, but the effect was not caused by the goal. For example, a person can have the goal to interrupt a process and the process is indeed interrupted. Yet, the goal did not cause the interruption;, something else did.

It is good to bear in mind that the terms *controlled* and *uncontrolled* are not synonymous with the terms *controllable* and *uncontrollable*. The former terms refer to an actual state of affairs; the latter terms refer to a possibility. A process is controlled (here and now) when a goal is active and causes the desired effect. A process is uncontrolled (here and now) when at least one of the three ingredients (goal, effect, causal relation between goal and effect) is missing. A process is controllable when there is at least one occasion on which activation of the goal causes the desired effect. A process is uncontrollable when there is no occasion whatsoever on which activation of the goal causes the desired effect. A process that is currently uncontrolled may be controlled on other occasions, and hence be controllable.

(Un)intentional

A process is intentional when a person has the goal to engage in the process and this goal causes the occurrence of the process. It may be noted that intentional is identical to controlled in the promoting sense. Thus, intentional processes are a subset of controlled processes. Likewise, unintentional processes are a subset of uncontrolled processes. A process is unintentional when the process is present but the goal to engage in the process is absent. A process is also unintentional when both the process and the goal to engage in the process are present but the causal relation between them is absent.

It is good to keep in mind that a process can be intentional under one description but unintentional under another (e.g., Searle, 1983). For example, a person can evaluate a job candidate in an intentional manner but, while doing so, activate stereotypes about the person in an unintentional manner. The same process is intentional under the description of evaluating a person but unintentional under the description of activating stereotypes.

(Non)autonomous

A process is autonomous when it is uncontrolled in both the promoting and the counteracting sense. A process is autonomous when it is not caused by the goal to engage in it and when it is not counteracted by a goal to counteract it. Autonomous processes are a subset of uncontrolled processes. They are at the intersection of processes that are uncontrolled in the promoting sense (i.e., unintentional) and those that are controlled in the counteracting sense. A process can be partially autonomous. For example, a process can be controlled in the promoting sense but uncontrolled in the counteracting sense.

Goal (In)dependent

A process is goal dependent when a person has a goal (any goal) and this goal causes the occurrence of the process. The goal may be either the proximal goal to engage in the process, or a remote goal that is not about the process. In the first case, the process is goal dependent and intentional; in the second case, the process is just goal dependent. Intentional processes are a subset of goal-dependent processes because intentions are a subset of goals; they are goals to engage in an act or a process. To illustrate these notions, the act of moving one's arm toward one's head may be caused by the proximal goal to move the arm toward the head (in this case the act is intentional) or directly by the goal to scratch the head (in this case the process is unintentional but goal dependent). Another scenario is that the remote goal causes the proximal goal, and that the latter, in turn, causes the process. The goal to scratch the head may cause activation of the goal to move the arm toward the head and this, in turn, may cause the arm to move toward the head. A process is goal independent when it is not caused by a (proximal or remote) goal.

Intentional processes are a subset of both goal-dependent processes and controlled ones; they are at the intersection of both. In the case of goal-dependent processes, the goal can be about

the process (e.g., the proximal goal to engage in the process, -in which case the process is intentional) or not about the process (a remote goal). In the case of controlled processes, the goal is always about the process. The goal can be of the promoting type (i.e., the goal to engage in the process, -in which case the process is intentional) or of the counteracting type (e.g., the goals to change, interrupt, or prevent the process). In the case of goal-dependent processes, the effect consists in the occurrence of the process. In the case of controlled processes, the effect can be manifold: the occurrence, a change, the interruption, or the prevention of the process.

(Un)conscious

Many theorists have distinguished two aspects or ingredients of consciousness: an aboutness aspect and a phenomenal aspect. The aboutness aspect refers to the fact that consciousness is about something, that it has content; the phenomenal aspect refers to subjective feeling or qualia. The aboutness aspect is said to depend on attention, whereas the phenomenal aspect is said to escape attention. Block (1995) even argued that there are two types of consciousness based on these two aspects: access-consciousness (or A-consciousness) and phenomenal consciousness (or P-consciousness). The feature unconscious refers to the absence of consciousness. The terms *conscious* and *unconscious* can be used as predicates of several things. They can refer to (a) the stimulus input of the process, (b) the output of the process, and (c) the process itself (i.e., the relation between input and output when the process is defined on a functional level of analysis). Processes that operate on conscious input can be unconscious themselves. Examples are the processes involved in reading and driving a car. Therefore, it is recommended to always specify the predicates of the terms *conscious* or *unconscious*.

(Non)efficient

A process is efficient when it consumes little or no attentional capacity. The central ingredient of the feature efficient is attention. Attention has two aspects: a quantity and a direction.[2]. Efficiency is only related to the quantity aspect. A process is efficient when it operates with very little or without this quantity. It is nonefficient when it consumes a substantial amount of this quantity.

Processes that depend on the direction of attention do not necessarily use a large amount of attention. For example, affective priming effects have been shown to disappear when attention was not directed at the primes (Musch & Klauer, 2001). This suggests that evaluation of the primes depends on the direction of attention. It is possible, however, that this evaluation process used only a small amount of attention and therefore still counts as efficient.

Like consciousness, attention may be directed at (a) the stimulus input of a process, (b) the output of a process, or (c) the process itself. It is also useful to distinguish (a) attention to a stimulus (i.e., stimulus-based attention) from (b) attention to a stimulus feature (feature-based attention), (c) attention to the spatial location in which the stimulus is presented (i.e., spatial or space-based attention), and (d) attention to the time window in which the stimulus is presented (i.e., temporal attention). Attention may have various objects, but the term *efficien*t can only be used as a predicate of a process or behavior. In cases in which various processes may be at work, it is important to specify the process that one considers to be efficient.

Fast (Slow)

The central ingredient of the feature fast is duration. A fast process is one with a short duration; a slow process is one with a long duration. The duration of a process should not be conflated with the duration of the stimulus input on which the process operates. A slow process may operate on a briefly presented stimulus, and a fast process may operate on a stimulus that is presented for a long time. The term *fast* can only be used as a predicate of a process.

Purely Stimulus Driven

A process is purely stimulus driven when the only condition necessary for its occurrence is the presence of the stimulus. Purely stimulus-driven processes may require some background conditions (such as being awake and that the light is on in the case of visual stimuli) in addition to the stimulus input, but they do not require the presence of goals, consciousness, and attention. Thus, purely stimulus-driven processes are at the intersection of goal-independent processes, unconscious processes, and efficient processes. They are a subset of each of these sets of processes.

Features Provide Information About Operating Conditions

Automaticity features are not fixed features of processes. A process can be unintentional on some occasions but intentional on others, or it can be intentional at first but unintentional after practice. This has led to the proposal to view and redefine features of (non)automaticity in terms of operating conditions (Bargh, 1992). The features discussed earlier can be reformulated as follows. A process is uncontrolled in the promoting sense (intentional) when it occurs in the absence of a (causally efficacious) promoting goal (i.e., goal to engage in the process). A process is uncontrolled in the counteracting sense when it occurs despite the presence of (or even in the absence of) a (causally efficacious) counteracting goal or in the absence of a (causally efficacious) counteracting goal. A process is autonomous when it occurs in the absence of a (causally efficacious) promoting goal and despite the presence (or in the absence of) a (causally efficacious) counteracting goal or the absence of a (causally efficacious) counteracting goal. A process is goal independent when it occurs in the absence of any (causally efficacious) goal. A process is unconscious when it occurs in the absence of consciousness of the process. A process is efficient when it occurs in the absence of a large amount of attentional capacity. A process is

fast when it occurs in the absence of a large amount of time. A process is purely stimulus driven when it occurs in the absence of goals, attention, and consciousness.

Extending the Set of Operating Conditions

I suggest that the range of possible conditions that influence the occurrence (or non-occurrence) of processes—and that are therefore worthy of study—can be extended beyond those that are related to (non)automaticity features (cf. Moors, Spruyt, & De Houwer, 2010). One example of a condition that is not included in most lists of automaticity features is salience, the quality of a stimulus (or stimulus feature) to stand out relative to other stimuli (or stimulus features; Itti, 2007). Salience is a property of a stimulus, but a stimulus is always salient for a person. Salience corresponds to the subjective intensity of a stimulus relative to other stimuli. The subjective intensity of a stimulus must be delineated from the objective intensity of a stimulus. Objective stimulus intensity corresponds to luminance in the visual domain, to amount of decibels in the auditory domain, and to amount of pressure in the tactile domain. Salience of a stimulus can be influenced by various factors such as the objective intensity, clarity, size, duration, and frequency of a stimulus, as well as by goals, expectations, attention, and recency (whether a representation of the stimulus was recently activated). Another condition that is not related to one of the automaticity features is the direction of attention. Some processes only occur when attention is directed to the stimulus or to the location of the stimulus (cf. Musch & Klauer, 2001). The list of possible conditions can, in principle, be extended to include any concrete or abstract aspect of an experimental procedure (e.g., specific instructions, stimulus set, context).

Operating conditions can be split into two groups: internal and external ones. Most of the conditions discussed here are internal. They refer to internal ingredients such as goals,

consciousness, and attention, and salience. Some conditions are external. They refer to external ingredients such as, duration, frequency, and objective intensity of stimuli.

It may be noted that in the case of internal operating conditions, there is often reference to a process (e.g., the goal to engage in or counteract a process, consciousness of a process, attention directed at a process). It is most likely that the processes that are referred to in these conditions are described at a high but not at a low level of analysis. For example, a person can become *aware* that she is engaged in the high-level process of evaluation, but probably not that she is engaged in the low-level process of activating associations. Likewise, a person can have the *goal* to engage in the high-level process of evaluation, but probably not the goal to engage in the low-level process of activating associations.

Relations Among Features or Operating Conditions

Various feature-based views of automaticity differ with regard to the amount of coherence they assume among features. Features have been grouped into two modes (dual-mode view) or three modes (triple-mode view), or they have been considered as entirely separable (essence view; decompositional view).

Dual-Mode View

The dual-mode view proposes that there are two modes of processing and behavior: the automatic mode and the nonautomatic mode. This view assumes a perfect coherence among the features of each mode. Assumptions of coherence stem from assumptions of conceptual overlap and logical relations among the ingredients of (non)automaticity features (see Moors, 2009, for a discussion of other sources of the dual-mode view). For example, the coherence among the features conscious and controlled stems from the idea that consciousness is an ingredient of control (i.e., conceptual overlap; e.g., Prinz, 2004) or that consciousness is a necessary condition for control

(e.g., Uleman, 1989). For another example, the coherence among the features efficient and unconscious stems from the idea that consciousness and attention are identical or that attention is necessary and sufficient for consciousness (e.g., De Brigard & Prinz, 2010; Prinz, 2010, in press).

Because of the coherence among the features of each mode, processes in the automatic mode possess all automatic features, and those in the nonautomatic mode possess all nonautomatic features. The dual-mode view is therefore also called an all-or-none view.

The implications of the dual-mode view for the diagnosis of processes or behavior as automatic are the following: A process can be diagnosed as automatic when it has been demonstrated that it possesses one feature of automaticity. The remaining features of automaticity can then be inferred. In other words, evidence for the presence of one feature of one mode can be generalized to the remaining features of that mode. Proponents of the dual-mode view think of (non)automaticity features as fixed features of processes. In their view, (non)automaticity features do not refer to conditions that are sometimes present and sometimes not. In addition, they do not usually consider the influence of factors that are not included in the automaticity concept (such as salience).

It has become clear, however, that the dual-mode view is untenable. Studies have demonstrated that many processes possess a combination of automaticity and nonautomaticity features. For example, studies have demonstrated that the processes underlying the affective priming effect can be unintentional (e.g., Bargh, Chaiken, Raymond, & Hymes, 1996) and unconscious (e.g., Klauer, Eder, Greenwald, & Abrams, 2007), but that they can also be controlled in the counteracting sense (Teige-Mocigemba & Klauer, 2008). Lachter, Foster, and Ruthruff (2008) have shown that the processes underlying the word repetition priming effect can be unintentional and unconscious, but nevertheless depend on (the direction and quantity of) attention. The processes underlying the colour word Stroop effect have been shown to be

unintentional and difficult to counteract. Yet, studies showing a dilution of the Stroop effect when the to-be-named colours are spatially separated from the colour words (e.g., Kahneman & Chajczyk, 1983; Lachter, Ruthruff, Lien, & McCann, 2008) suggest that these processes are influenced by (the direction and quantity of) attention. This and other evidence led researchers (e.g., Bargh, 1989; Shiffrin, 1988) to abandon the dual-mode view.

Triple-Mode View

One alternative to the dual-mode view is the triple-mode view. Several authors have separated nonautomatic processes from two types of automatic processes. Carver and Scheier (1999, 2002) distinguished between bottom-up automatic processes and top-down automatic processes. These two types of automatic processes come about at different stages in the evolution of a process during practice. In the initial stages of practice, there are bottom-up processes that are triggered by mere stimulus input. These processes are so weak that they remain inaccessible to consciousness and they cannot be controlled (i.e., bottom-up automatic stage). In intermediate stages of practice, processes become so strong that they become consciously accessible. As a result, they can be controlled (i.e., nonautomatic stage). In later stages of practice, processes become so strong and well-trained that control is no longer required and they fall out of consciousness again (i.e., top-down automatic stage). Top-down automatic processes are usually unconscious, but they are not inaccessible to consciousness. They can become conscious when attention is directed to them. Several attention researchers made a similar distinction between pre-attentive automatic processes and learned ones (e.g., Treisman, Vieira, & Hayes, 1992). Preattentive automatic processes are those involved in the early stages of the processing sequence (e.g., sensory analysis). Learned automatic processes are those that become independent of attentional capacity as a result of practice. It may be noted that bottom-up automatic processes

may not overlap entirely with pre-attentive ones. Not all unlearned automatic processes may be situated in the early stages of the processing sequence.

The triple-mode view faces the same problems as the dual-mode view. It is based on assumptions of coherence among features. For example, a strong coherence is assumed between the features conscious and controlled. It is assumed that a process can be controlled when it is conscious, and that a process falls out of consciousness when control is no longer required.

The implications of the triple-mode view for the diagnosis of processes or behavior as automatic are practically the same as those of the dual-mode view. Even though there are two types of automatic processes, both types include all automatic features and these cohere perfectly. Thus, a process can be diagnosed as automatic when it is demonstrated that it possesses one feature of automaticity (the other features can then be inferred).

Essence View

The lack of coherence among automaticity features has led some authors to choose one necessary feature (i.e., an essence) that a process should have to belong to the set of automatic processes. The remaining features of automaticity are considered optional. For example, Bargh (1992) proposed to call a process automatic when it runs to completion without the need for conscious guidance, regardless of how it was initially caused (by a goal or not). Such processes can be called a special type of partially autonomous processes. The start of the process can be caused or not caused by a promoting goal. The completion of the process is not caused by a conscious goal (but it can still be caused by an unconscious goal, I presume).

To diagnose a process as automatic according to an essence view, one should investigate whether the process possesses the essential feature. The problem is that the choice of such a feature is always an arbitrary matter.

Decompositional View

Another view that does not assume a priori coherence among the features of each mode is the decompositional view. According to this view, processes can, in principle, possess any random combination of automatic and nonautomatic features. It is up to empirical research to determine which features cohere in reality. The decompositional view rests on the assumption that most features of automaticity can be separated on conceptual and logical grounds.

Most features can be conceptually separated. They can be defined in such a way that they do not share ingredients. In the definitions of (non)automaticity features presented earlier, the goal-related features (un)controlled, (un)intentional, (non)autonomous, and goal (in)dependent do not overlap with (un)conscious, (non)efficient, and fast (slow) because they do not make reference to consciousness, attention, or duration. The features (un)conscious, efficient, and fast can also be conceptually separated from each other because they do not share ingredients (aboutness aspect, phenomenal aspect, attentional capacity, and duration). The definitions presented earlier do entail conceptual overlap among several goal-related features, as well as among purely stimulus -driven and several other features. (Un)intentional processes are at the intersection of (un)controlled processes and goal-(in)dependent ones. Autonomous processes are at the intersection of processes that are uncontrolled in the promoting sense and ones that are uncontrolled in the counteracting sense. Purely stimulus-driven processes are at the intersection of goal-independent processes, unconscious ones, and efficient ones. On the other hand, processes that are (un)controlled in the promoting sense (i.e., [un]intentional) do not overlap with ones that are (un)controlled in the counteracting sense because they are based on different types of goals (promoting vs. counteracting).

Most features can also be logically separated. This does not mean that there are no relations among features. Ingredients of features do influence each other. The decompositional view, however, starts from the working hypothesis that these relations are not one-to-one relations. No ingredient is considered a necessary and/or sufficient condition for another ingredient. Figure 11.1 shows possible relations among the ingredients of (non)automaticity features and other operating conditions. As the figure shows, all ingredients are multi-determined. I discuss five sets of relations:

(1) Goals influence attention. The presence of a goal increases the likelihood that attention will be allocated to something. The content of the goal influences the direction (and hence object) of attention (e.g., Allport, 1989; Yantis, 2000). It seems reasonable to assume that this also holds for processing goals. The goal to engage in a process may steer attention to a suitable stimulus input. For example, the goal to evaluate a job candidate may steer attention to the candidate. The goal to counteract a process may steer attention to the process itself. For example, the goal to counteract the process of stereotyping may call attention to this process. However, attention is not exclusively influenced by goals. Other possible factors are expectations, salience, and mismatches with goals (i.e., significance), mismatches with expectations (i.e., unexpectedness), and mismatches with memory representations (i.e., novelty) (e.g., Gati & Ben-Shakar, 1990; Mack & Rock, 1998; Öhman, 1992; Yantis, 2000).

(2) Attention influences consciousness. Relying on the distinction between the direction and the amount of attention, one can distinguish between two types of influences. First, the direction of attention influences the content of consciousness (e.g., Posner, 1994; Shiffrin & Schneider, 1977; Posner, 1994): Attention to a stimulus (or process) renders the stimulus (or process) conscious and not another one. Second, the amount of attention

spent on something determines the likelihood that it will become conscious (or the amount of consciousness, for gradual views of consciousness). Empirical support for both types of influence comes from effects known as inattentional blindness (an unexpected stimulus with a long duration and high objective intensity fails to reach consciousness when attention is directed to another stimulus, e.g., Mack & Rock, 1998), change blindness (i.e., a change in a visual pattern does not become conscious when attention is not focused on the changing part, e.g., Rensink, O'Regan, & Clark, 1997), the attentional blink (i.e., a stimulus fails to reach consciousness when attention is consumed by another stimulus that is presented around 200 ms earlier; Raymond, Shapiro, & Arnell, 1992), and load-induced blindness (i.e., the threshold for consciousness of a stimulus increases when attentional capacity is consumed by a secondary task; Macdonald & Lavie, 2008). The former two effects (inattentional blindness and change blindness) seem to be more supportive of the first type of influence (that the direction of attention influences the content of consciousness), whereas the latter two (attentional blink and load-induced blindness) seem more supportive of the second type of influence (that the amount of attention spent influences the likelihood or amount of consciousness).

Everybody agrees that attention influences consciousness, yet there is strong disagreement about whether attention is necessary and/or sufficient for consciousness. Some theorists hold that attention is *necessary* for consciousness (e.g., Kouider & Dehaene, 2007; De Brigard & Prinz, 2010), whereas others deny this (e.g., Koch & Tsuchiya, 2007; van Boxtel, Tsuchiya, & Koch, 2010). Still others argue that attention is necessary for some but not all aspects or types of consciousness. For example, Block (1995) distinguishes between access consciousness, which is dependent of attention, and phenomenal consciousness, which is not dependent of attention. In addition to these two first-order types of

consciousness, there is a second-order type of consciousness, which is typically thought to be dependent of attention as well.

[Figure 11.1 here]

To demonstrate that attention is *necessary* for consciousness, one should demonstrate that in all instances in which attention is absent, consciousness is absent as well. To demonstrate that attention is *not necessary* for consciousness, one should find one instances in which consciousness is present but attention is absent. Investigating all instances in which attention is absent is not a realistic purpose. Common empirical practice consists of demonstrating one or a few instances in which attention and consciousness are both absent. These results are generalized to other instances. Examples of instances in which attention and consciousness are both absent are phenomena such as inattentional blindness, change blindness, attentional blink, and load blindness. Critics have questioned whether consciousness is really absent in these studies. For example, van Boxtel et al. (2010) review studies in which it is shown that participants in inattentional blindness studies are still conscious of the gist of the unattended stimuli. These studies count as evidence that attention is not necessary for consciousness. In turn, this (and other) evidence has been criticized on the grounds that attention is not really absent in these studies (e.g., Prinz, 2010).

Some theorists hold that attention is *sufficient* for consciousness. More precisely, these theorists hold that attention to X is sufficient for consciousness of X. Attention to a location (i.e., space-based attention) is sufficient for becoming conscious of that location; attention to a feature (i.e., feature-based attention) is sufficient for becoming conscious of that feature; and attention to a stimulus (i.e., stimulus-based attention) is sufficient for becoming conscious of that stimulus. They do not make the claim that attention to a location is

sufficient for becoming conscious of the stimulus presented in that location (De Brigard & Prinz, 2010; Mole, 2008).

To demonstrate that attention is *sufficient* for consciousness requires demonstrating that in all instances in which attention is present, consciousness is present as well. Investigating all instances in which attention is present is not a realistic purpose. Common empirical practice consists of demonstrating instances in which both attention and consciousness are present. These findings are generalized to other instances or it is provisionally maintained that attention is sufficient for consciousness until someone comes up with evidence to the contrary. To demonstrate that attention is *not sufficient* for consciousness, one should demonstrate that attention is present when consciousness is absent. Evidence for this position is adduced by (a) subliminal priming studies showing that attention influences the likelihood of unconscious processing (Lachter, Forster, & Ruthruff et al., 2004; Naccache, Blandin, & Dehaene, 2002), and (b) attentional bias studies showing that unconscious stimuli influence the direction of attention (Jiang, Costello, Fang, Huang, & He, 2006). Critics have argued that the data do not convincingly demonstrate that attention was directed to the stimulus (stimulus-based attention) instead of to the location of the stimulus (space-based attention) (Prinz, 2010). Recent studies have demonstrated that feature-based attention is possible in the absence of consciousness of the stimulus, but whether or not stimulus-based attention is possible in the absence of consciousness of the stimulus remains a matter of debate (e.g., Tapia, Breitmeyer, & Broyles, 2011; Tapia, Breitmeyer, & Shooner, 2010).

Another way of demonstrating that attention is not sufficient for consciousness is to show that there are other factors besides attention that are necessary for consciousness. Factors that

have been mentioned as necessary conditions for consciousness are stimulus intensity (Kouider & Dehaene, 2007) and stimulus duration (Prinz, 2010). It seems that even defenders of the position that stimulus-based attention is sufficient for consciousness think that stimulus intensity and stimulus duration are necessary conditions. If they indeed agree that these other conditions are necessary, how can they maintain that attention is sufficient for consciousness? One proposal offered by these authors is that intensity and duration act as conditions for attention. Only when intensity and duration are high enough, can attention can do its work. And once attention does its work, consciousness is a fact (cf. Prinz, 2010). Another proposal, however, is that the influence of attention, strength, and duration are additive (cf. Moors & De Houwer, 2007). Subliminal priming studies and threshold studies suggest that a lack of stimulus duration may be compensated by a high stimulus intensity and/or a high amount of attention directed to the stimulus. Likewise, a lack of stimulus intensity (e.g., when the stimulus is degraded) may be compensated by long presentation duration and/or a high amount of attention directed to the stimulus. Determining the precise nature of the relation between the ingredients attention, intensity, and duration remains a topic for future research. In the meanwhile, I think it is best to consider them as independent ingredients. This increases the likelihood that they are taken into account. Against the background of the ongoing debate between proponents and opponents of the claims that attention is necessary and/or sufficient for consciousness, I propose to define these ingredients in a non-overlapping way and to investigate their presence or absence separately.

(3) The salience or subjective intensity of a stimulus is influenced by factors such as goals, expectations, the direction and amount of attention, and the objective stimulus intensity. These factors may also be additive.

(4) The presence of a salient and/or conscious stimulus (or process) influences the likelihood that a conscious goal of the promoting (or of the counteracting) kind will be implemented (cf. Shallice, 1988). For example, implementation of the goal to evaluate a job candidate is more likely when a job candidate is consciously available. Implementation of the goal to counteract the activation of stereotypes is more likely when the person is aware that this process is taking place. This being said, a conscious and/or salient stimulus input may not be necessary for the implementation of goals. The implementation of (conscious or unconscious) goals may suffice with an unconscious and/or nonsalient stimulus (or process) (e.g., Wolbers, Schoell, Verleger, Kraft, McNamara et al., 2006).

I wish to note that the set of interrelations among the ingredients sketched earlier is not exhaustive. Moreover, some relations have been empirically established, whereas others are theoretical possibilities that have not (or not sufficiently) been tested. Still other relations have been empirically investigated, but the interpretation of the results is subject to intense debate. Participants in these debates often use different definitions and models of attention and consciousness.

The arguments that motivate the choice for a decompositional view could also be taken as arguments to abandon the concept of automaticity altogether. This would indeed be an option. However, the decompositional view is also compatible with a gradual view of automaticity, which conceives of automaticity as a gradual concept (Shiffrin, 1988; Moors & De Houwer, 2006a, 2007; Shiffrin, 1988). The notion *gradual* applies to two things. First, processes can be automatic with regard to more or fewer features. The more features of automaticity a process has, the more automatic it is. Second, each of the automaticity features discussed can themselves be considered as gradual. A process can be more or less controlled, more or less conscious, more or less efficient, and more or less fast.

The implication of this view for the diagnosis of automaticity is the following. One cannot simply diagnose a process as automatic or nonautomatic. One can examine whether certain features of automaticity are present or absent, or the degree to which they are present. This allows one to diagnose a process as more or less automatic. The assumption that features are conceptually and logically separable has the implication that each feature has to be investigated separately. The presence of one feature cannot be inferred from the presence of another feature.

Conclusion

The present chapter discussed one mechanism-based view and four feature-based views of automaticity. The feature-based views differ with regard to the amount of coherence that they assume among features of automaticity. The dual-mode view proposes to organize processes into an automatic and a nonautomatic mode and assumes that there is perfect coherence among the features of each mode. The triple-mode view proposes to organize processes into three modes: a bottom-up automatic mode, a top-down automatic mode, and a nonautomatic mode. The essence view proposes to elect one feature as the necessary feature and to consider all the other features as optional ones. Like the decompositional approach, this view argues that there is no (a priori) coherence among features of automaticity. All features can be conceptually and logically separated and processes can, in principle, possess any random combination of features.

For each of the views discussed, it was examined what the implications are for the diagnosis of a process or behavior as automatic. The mechanism-based view recommends diagnosing a (functional-level) process as automatic when it is based on an associative mechanism (on the algorithmic level). The dual-mode view and the triple-mode view recommend diagnosing a process as automatic when there is evidence for the presence of one automaticity feature. From this, it can be inferred that the remaining automaticity features are present as well.

The essence view recommends investigating the presence of the feature that is deemed essential. According to the gradual, decompositional view defended in this chapter, a process or behavior cannot be diagnosed as either automatic or nonautomatic. It can be diagnosed as more or less automatic based on the number of features that are present and the degree to which they are present. Instead of making absolute claims about automaticity, investigators can make relative claims about the automaticity of a process relative to other processes or relative to other occasions or stages of practice.

I elaborated the feature-based view with the proposal to reformulate features in terms of operating conditions. This opens the door for extending the set of conditions with ones that are not related to automaticity features. If the set of conditions is extended in this way, I suggest talking about processes that occur under optimal vs. suboptimal conditions instead of about processes that are nonautomatic vs. automatic. Suboptimal conditions include the absence of a promoting goal, the presence/absence of a counteracting goal, the absence of a remote goal, the absence of a conscious stimulus input, the absence of a large amount of attentional capacity, the absence of attention being focused on the stimulus input, the absence of a large amount of time, and the absence of an objectively or subjectively intense stimulus input. Optimal conditions include the opposites of these conditions.

Future Directions

Future research aimed at diagnosing the automaticity of processes or behavior may benefit from the following recommendations:

(1) A first recommendation from the decompositional view is to investigate features of automaticity one by one. When calling some process automatic, one should specify which feature of automaticity one has in mind. One should also specify whether the feature

under consideration can be applied to entire processes or to parts of them (inputs, outputs).

(2) My proposal to reformulate features in terms of operating conditions and to extend the set of operating conditions beyond those strictly related to automaticity features leads to a second recommendation. I recommend studying a series of conditions for the occurrence of a process, including ones that are not strictly related to automaticity features such as the direction of attention and objective or subjective stimulus intensity.

(3) The decompositional view recognizes that there are relations among the central ingredients that figure in the definitions of features or operating conditions. For example, research shows that goals do influence attention and that attention does influence consciousness. As argued earlier, however, there may not be one-to-one relations among these concepts. Attention can be influenced by other factors than goals, such as stimulus intensity. Likewise, consciousness can be influenced by other factors than attention, such as stimulus intensity and stimulus duration. The additional point that conditions may be interdependent has the implication that it is ultimately not very informative to have knowledge about a single operating condition. It is best to progressively investigate and map out the larger set of interdependent conditions at stake.

In conclusion, when calling a process automatic, one should specify the features of automaticity (or operating conditions) one has in mind, or even better, accompany them with empirical arguments. In addition, one should attempt to uncover the interrelations among the features (or operating conditions).

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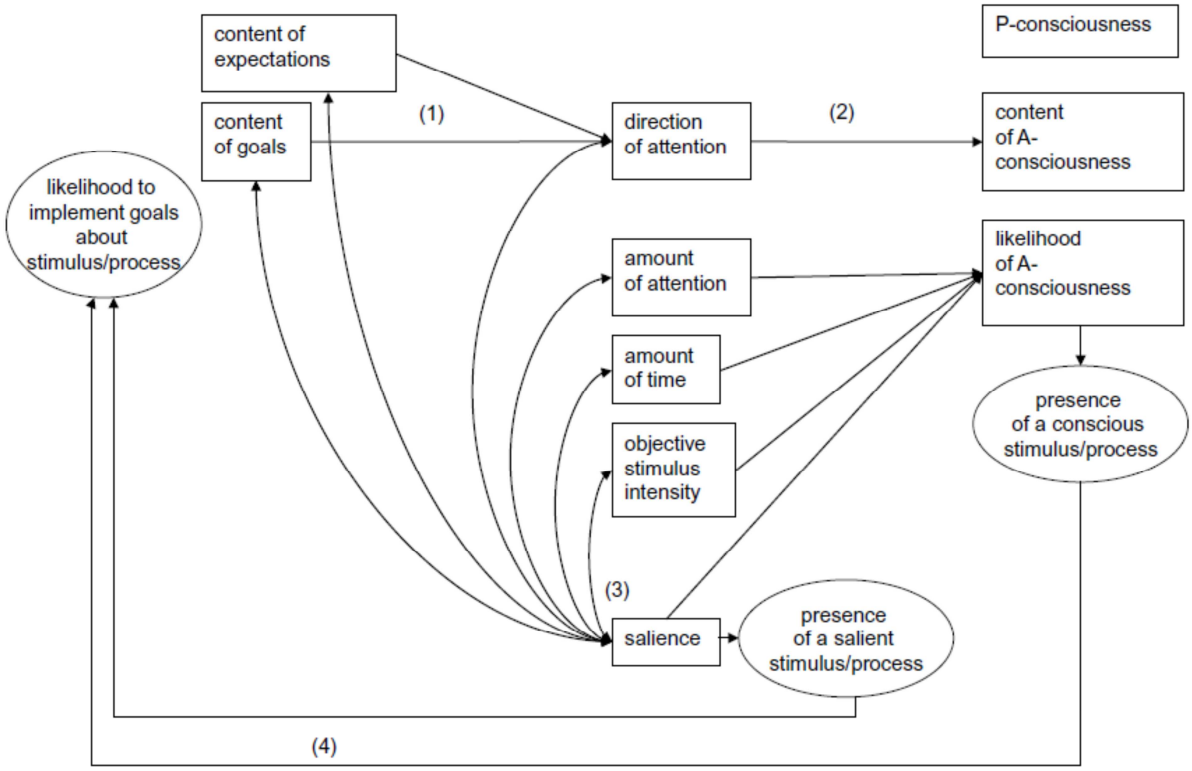
Footnotes

1. The term *goal* has two meanings. A first meaning is apparent in the phrase “a person/process is *directed toward* a goal.” Here, goal means a desired state in the future. One way in which a person can be directed toward a future state is by forming a representation of it. This leads to a second meaning of the term *goal,* which is apparent in the phrase “a person/process is driven or *caused by* a goal.” Here, goal means a representation of a state, which, when activated, may act as a cause.

2. Some authors have used these two aspects of attention (direction and quantity) as the basis for two types of attention (input attention and central attention) that have separate temporal loci, separate functions, and separate temporal and anatomical loci (cf. Johnston, McCann, & Remington, 1995). I prefer treating them as aspects that are not entirely separable. When attention is directed somewhere, there is always *some* amount of attention that is being spent.

Figure 11.1: Possible relations among the ingredients figuring in operating conditions


content of expectations
content of goals
(1)
direction of attention
(2)
P-consciousness
content of A-consciousness
likelihood to implement goals about stimulus/process
amount of attention
likelihood of A-consciousness
amount of time
presence of a conscious stimulus/process
objective stimulus intensity
(3)
salience
presence of a salient stimulus/process
(4)