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The Sequential Priming Paradigm: A Primer

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Introduction

Ask any cognitive psychologist to name three prototypical cognitive research paradigms and he or she will almost certainly name the sequential priming paradigm. At least one of the reasons why the sequential priming paradigm has become so popular over the past decades is its procedural simplicity. In a typical sequential priming study, participants are presented with a series of trials, each of which consists of the presentation of a prime stimulus followed by a target stimulus. Crucially, the relationship between the prime stimulus and the target stimulus is manipulated: On some trials both stimuli are somehow related whereas both stimuli are unrelated on other trials. What is typically found is an improvement in speed and/or accuracy to respond to the target stimulus when it is preceded by a related prime stimulus relative to when it is preceded by an unrelated prime stimulus (but see, for example, Glaser & Banaji, 1999). Another reason for the popularity of the sequential priming paradigm is undoubtedly its flexibility. The range of stimulus materials that can be used in the sequential priming paradigm is virtually unlimited and, depending on the specific research questions being evaluated (see below), different response tasks can be implemented. Most importantly, however, the sequential priming paradigm can be used to examine a wide range of hypotheses. At the most abstract level, these research questions can be divided in two broad categories (see also Moors, Spruyt, & De Houwer, 2010, for a related framework). We will refer to these categories as Process-I hypotheses and Process-II hypotheses. *Process-I hypotheses* concern the conditions under which the presentation of a stimulus leads to the activation of (at least part of) its representation in memory. *Process-II hypotheses*, concern the mechanisms that translate this prime activation into an observable priming effect.

As an example of a Process-I hypothesis, consider the hypothesis that the extraction of meaning from a word does not require the conscious identification of that word. To evaluate this hypothesis, one can think of a sequential priming experiment in which (a) participants

presented both with semantically related (e.g., *nurse* - *doctor*) and semantically unrelated prime-target pairs (e.g., *nurse* - *grass*) and (b) the prime words are presented under conditions in which they cannot be identified. If such an experiment would yield faster and/or more accurate responses to semantically related prime-target pairs than to semantically unrelated prime-target pairs, one can conclude that subliminal semantic stimulus processing must have taken place. In fact, this is exactly the research strategy that was implemented in a large number of subliminal priming studies (e.g., Dagenbach, Carr, & Wilhelmsen, 1989; Draine & Greenwald, 1998; Hirshman & Durante, 1992; Holender, 1986; Marcel, 1983; Naccache & Dehaene, 2001). To be sure, there have been intense discussions about the effectiveness of different procedures to prevent conscious identification of the primes (e.g., Holender, 1986; Reingold & Merikle, 1988). There even have been discussions about the theoretical definition of what it really means to say that participants are 'unaware' of the primes (e.g., Cheesman & Merikle, 1984; Macmillan, 1986). But very few researchers will disagree with the general principle that the sequential priming paradigm is a valuable research tool for examining this issue. Other conditions under which semantic stimulus processing can take place have been examined in a similar fashion (see McNamara, 2005, for an excellent review).

As an example of a Process-II hypothesis, consider the issue of (automatic) non-associative semantic priming. Associative relatedness can be defined as the extent to which the activation of one concept will call to mind another concept due to their repeated temporal or spatial co-occurrence (e.g., *Laurel* - *Hardy*). Semantic relatedness, on the other hand, can be defined as the extent to which concepts are similar in meaning or overlap in featural description (e.g., *cat* - *lion*). Although both types of relationship often co-vary, stimuli can either be highly associated yet semantically unrelated (e.g., *book*-*worm*) or weakly associated yet semantically similar (e.g., *whale* - *elephant*). Ever since Meyer and Schvaneveldt (1971) published their seminal article on semantic priming, numerous research attempts have been

undertaken to determine whether or not associative relatedness is a prerequisite for automatic semantic priming to occur (e.g., Fischler, 1977; Lucas, 2000; McRae & Boisvert, 1998; Shelton & Martin, 1992). This issue is important theoretically because uncovering the types of relationships that can produce priming is potentially informative about the functional structure of semantic memory. This line of research is unrelated, however, to hypotheses that concern the conditions under which semantic stimulus processing can take place (i.e., Process-I hypotheses). What is being evaluated here are hypotheses concerning the mechanisms by which the activation of one memory representation results in the activation of other memory representations (i.e., Process-II hypotheses).

In sum, observable priming effects always require two sequential steps.[1] The first step concerns the activation of a memory representation by a certain stimulus. The second step concerns the mechanisms that translate this activation into an observable priming effect. While this general idea may seem almost trivial at first sight, we will demonstrate that it is quite easy to confound Process-I and Process-II hypotheses later in this chapter.

Benefits

Given the long-standing research tradition in sequential priming as well as the flexibility and procedural simplicity of the sequential priming paradigm itself, it is anything but surprising that the sequential priming paradigm has become a common research tool in various research domains. Social psychologists too have implemented the paradigm to address different research questions, especially in the field of social cognition. Consider, for example, the studies on automatic stereotyping by Blair and Banaji (1996; see also Banaji & Hardin, 1996). These authors set up a sequential priming experiment in which masculine and feminine personality traits (e.g., *caring, athletic, dependent, arrogant*) were used as primes and common male and female first names were used as targets (Experiment 1). In line with the

hypothesis that stereotypes can be activated automatically, participants were found to respond faster to stereotypic prime - target trials (e.g., *gentle - Jane, strong - John*) as compared to counterstereotypic prime - target trials (e.g., *gentle - John, strong - Jane*).

The sequential priming paradigm has also been used in studies on so-called spontaneous ingroup projection. According to the ingroup projection model of Mummendey and Wenzel (1999), group members project ingroup features onto superordinate categories. To evaluate this hypothesis, Bianchi, Mummendey, Steffens, and Yzerbyt (2010) set up a sequential priming study in which German and Italian participants were presented with targets words that referred to stereotypical Italian (e.g., *warm*) and German (e.g., *efficient*) traits. The prime set consisted of two group labels (i.e., *Italian, German*), one superordinate category label (i.e., *European*), and a neutral letter string (i.e., *XXXXXXXX*). In line with the hypothesis that the cognitive representation of a superordinate category is based on ingroup traits, Bianchi et al. (2010) found participants to respond faster to ingroup targets as compared to outgroup targets when they were primed with the superordinate category label.

Many more examples of social-psychological studies in which the sequential priming paradigm was used as a research tool can be found in the literature. There is probably no other line of research, however, in which the sequential priming paradigm is used in a more routine fashion than in research on automatic attitude activation. In this line of research, participants are typically presented with primes and the targets that have a clear affective connotation and the affective congruence of both stimuli is manipulated. Whereas both stimuli share the same affective connotation on some trials (e.g., *murder - disgusting, love - cute*), other trials consist of affectively incongruent prime - target pairs (e.g., *murder - cute, love - disgusting*). What is typically found is an improvement in speed and/or accuracy to respond to target stimuli that are preceded by an affectively congruent prime stimulus relative to target stimuli that are preceded by an affectively incongruent prime stimulus. Crucially, such an effect (hereinafter

referred to as *affective priming effect*; see Fazio, 2001; Hermans, De Houwer, & Eelen, 1994) can come about only if the valence of the primes has been processed. To the extent that attitudes can be viewed as simple associations between a given object and a given evaluation (Fazio, Chen, McDonel & Sherman, 1982; Fazio, Sanbonmatsu, Powell, & Kardes, 1986), the affective priming effect can thus be used as a cognitive marker of attitude activation (De Houwer, Hermans, & Spruyt, 2001).

Ever since Fazio et al. (1986) published their seminal paper on the affective priming effect, this logic has been applied to evaluate a wide range of (Process-I) hypotheses concerning the conditions under which attitudes can become activated (for reviews, see Fazio, 2001, Klauer & Musch, 2003). Several researchers, for example, have examined whether the affective priming effect can be replicated using subliminal primes (e.g., Abrams, Klinger, & Greenwald, 2002; Draine & Greenwald, 1998; Klinger, Burton, & Pitts, 2000; Greenwald, Klinger, & Schuh, 1995). Although affective priming effects tend to be less reliable when prime stimuli are presented subliminally (e.g., Hermans, Spruyt, De Houwer, & Eelen, 2003), research on subliminal affective priming has produced convincing evidence for the hypothesis that attitude activation does not depend upon the conscious identification of the instigating stimulus (Abrams et al., 2002; Draine & Greenwald, 1998; Klinger et al., 2000; Greenwald et al., 1995). In a similar fashion it has been demonstrated that attitude activation is an efficient (Hermans, Crombez, & Eelen, 2000) and fast-acting process (e.g., Fazio et al., 1986; Hermans, De Houwer, & Eelen, 2001; Klauer, Roβnagel, & Musch, 1997; Spruyt, Hermans, De Houwer, Vandromme, & Eelen, 2007) that is not dependent upon the activation of an (explicit) evaluative processing goal (e.g., Bargh, Chaiken, Raymond, & Hymes, 1996; Hermans et al., 1994; Spruyt, Hermans, De Houwer, & Eelen, 2002). The general conclusion of this line of research therefore is that, consistent with current theories on social cognition, attitude activation can take place in an unconditional, automatic fashion (but see Spruyt, De

Houwer, Hermans, & Eelen, 2007; Spruyt, De Houwer, & Hermans, 2009).

Even more important from a social-psychological point of view are studies in which the affective priming effect is exploited as a measure of automatic attitude activation, either at the group level or as an individual difference measure. Consider, for example, the seminal study by Fazio, Jackson, Dunton, and Williams (1995). These authors asked participants to complete an affective priming task in which pictures of black and white faces were used as primes. The participants' task was to evaluate whether the connotation or the target stimuli was pleasant of unpleasant. Results showed that, relative to what was observed for white prime faces, black faces facilitated responding to negative targets and inhibited responding to positive faces. If it is assumed that the affective priming effect reflects automatic attitude activation (see above), this finding suggests that, on average, the black faces activated negativity in an automatic fashion. While this finding is interesting by itself, the most interesting aspect of Fazio et al.'s findings relates to the predictive validity of the idiosyncratic affective priming effects obtained. More specifically, Fazio at al. (1995) found affective priming estimates of automatically activated racial attitudes to be predictive of how friendly participants later behaved while interacting with a black person. In a similar fashion, Dovidio and colleagues demonstrated that affective priming measures of racial attitudes can be used to predict spontaneous, race-related behaviors such as the amount of eye contact between a participant and a black vs. white interviewer (Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997; see also Dovidio, Kawakami, & Gaertner, 2002). Since these seminal demonstrations, many more studies attesting to the predictive validity of affective priming measures have appeared in the literature (for a review, see Fazio & Olson, 2003; see also Spruyt, Hermans, De Houwer, Vandekerckhove, & Eelen, 2007; Vandromme, Spruyt, & Hermans, in press; but see Bosson, Swann, & Pennebaker, 2000).

It must be emphasized, however, that these effects, albeit statistically significant, are

typically quite small. Consider, for example, Experiment 2 of Spruyt, Hermans, De Houwer, Vandekerckhove, et al. (2007). In this study, participants first completed an affective priming task in which pictures of candy bars and fruits were presented as primes. Next, after completion of the affective priming task, participants were asked to make a choice between a candy bar and an apple. Although idiosyncratic affective priming measures were clearly related to choice behavior in a meaningful manner, only 23 out of 35 individual choices (65.71 %) could be predicted correctly on the basis of the affective priming data. Therefore, unless the reliability and predictive validity of affective priming measures could be improved to a significant extent, the true value of the affective priming paradigm lies not so much in its use as a assessment tool, but rather in its use as a research tool that allows for an empirical evaluation of different theories on social behavior and automatic attitude activation.

Underlying Processes

As explained above, the occurrence of a sequential priming effect always requires two sequential steps: (a) the activation of memory representations by the primes (Process I), and (b) the translation of this activation into an observable priming effect (Process II). In this section, we (selectively) review different theories concerning the second step, i.e. processes that underlies the sequential priming effect itself. Roughly, theoretical models of sequential priming can be divided into three categories (see also De Houwer, 2003): (a) models that explain the sequential priming effect in terms of non-automatic, strategic processes, (b) models that explain the sequential priming effect in terms of Stimulus-Stimulus (S-S) compatibility, and (c) models that explain the sequential priming effect in terms of irrelevant Stimulus-Response (S-R) compatibility.

Non-automatic, Strategic Processes.

Researchers often turn to the use of the sequential priming paradigm because sequential priming effects are assumed to reflect automatic processes. It is important to realize, however, that sequential priming effects can also be brought about by non-automatic, strategic processes. Well-known examples are expectancy generation and post-access relatedness checking (Neely, 1991). According to an expectancy generation account of sequential priming, participants use the prime to generate a set of related candidates for the upcoming target (e.g., Becker, 1980; Neely, 1991). Responses may then be facilitated if an expected target appears and inhibited if an expected target does not appear. Note that expectancy generation can in principle be operative in any response task. In contrast, the scope of the second strategy, post-access relatedness checking, is somewhat more limited. Post-access relatedness checking refers to the search for a relation between the prime and the target subsequent to the target's presentation but prior to responding. The information concerning the prime-target relation can then be used as cue for response selection, at least if the absence or presence of a prime-target relationship is informative about what the correct response is (e.g., Balota & Lorch, 1986; de Groot, 1984; Neely, 1991). As an example, consider a semantic priming study in which participants are asked to decide whether target letter strings are words or non-words (i.e., the lexical decision task). In this task, the relation between the primes and the targets is informative about what the correct response is because the presence of such a relation implies that the target must be a word. Success in finding a relation between the primes and the targets may therefore lead to the facilitation of "word" responses. Conversely, a failure to find such a relationship on semantically unrelated prime-target pairs may lead to an inhibition of "word" responses and a facilitation of "non-word" responses.

Several measures can be undertaken, however, to counteract or at least minimize the operation of strategic processes. We will discuss these measures in the section “Nuts and Bolts” of this chapter.

S-S compatibility models.

Historically, S-S compatibility models of sequential priming have dominated the sequential priming literature. Although these models differ in several important ways, they all share the assumption that performance in the sequential priming paradigm depends on the compatibility between the prime and the target stimuli (see De Houwer, 2003; Kornblum & Lee, 1995). A complete review of different S-S compatibility models of sequential priming is beyond the scope of this chapter. We will therefore limit the discussion of these models to two, highly related examples: classic spreading activation models and distributed memory models (for a more exhaustive treatment of these models as well as other S-S compatibility models of sequential priming, see McNamara, 2005).

Undoubtedly, the most well-known class of S-S compatibility models are classic spreading activation models (e.g., Anderson, 1983; Collins & Loftus, 1975). According to these models, retrieving an item from memory amounts to activating its internal representation (McNamara, 2005). This activation is then assumed to spread to related representations and the residual activation that accumulates at concepts is assumed to facilitate their subsequent retrieval. For example, reading the prime word *bike* would cause activation to spread from the concept bike to the concept ‘car’. When the word *car* then appears as a target, the memory representation of ‘car’ would be more active than baseline. As a result of this heightened activation, lexical and semantic processing of the target stimulus is assumed to be facilitated.

Distributed network models are highly related to classic spreading activation models. According to these models, concepts are represented as patterns of activation across a large

network of interconnected processing units (see also Chapter 14, this volume). Typically, these processing units are organized into different modules that represent different types of information or accomplish different information-processing functions (McNamara, 2005). Masson's (1995) distributed memory model of semantic priming, for example, consists of three processing modules that represent orthographic, phonological, and semantic information. Each time a (trained) stimulus is presented to the input module of the network (e.g., the orthographic module in Masson's distributed memory model of semantic priming), the activation pattern in other modules will converge towards the complete activation pattern that was initially trained. Crucially, the more similar two patterns are, the less updating cycles are required to shift from one pattern of activation to another. These models therefore predict that target processing will be faster after the presentation of a related prime stimulus than after the presentation of a semantically unrelated prime stimulus (Masson, 1995, 1999; Smith, 1996; but see Dalrymple-Alford & Marmurek, 1999).

Turning to issue of social cognition, traditional spreading activation models as well as their distributed counterparts have been applied to account for various findings that have been obtained with the sequential priming paradigm. Automatic attitude activation, for example, has been described by Fazio et al. (1986) as a spread of activation in memory between the representation of a primed object and the associated evaluation (p. 231, see also Fazio, 2001). Moreover, if it is assumed that the activation level of the associated evaluation remains temporarily active after it has been activated, the affective priming effect itself can be attributed to the fact that less additional activation is required on affectively congruent trials to activate a target's associated evaluation. Note, however, that this conception of the affective priming effect does not require one to assume that all positive and negative concepts are interconnected in two associative networks (Fazio, 2001), nor does it imply the assumption that the mere activation of a prime representation is sufficient to pre-activate all

target representations with shared valence (the associative link between an object and its evaluation can be unidirectional, for example). In fact, most researchers in the field have explicitly rejected this possibility (e.g., Klauer et al., 1997; Wentura, 1999). Indeed, given that (a) stimulus valence is a feature that is shared by a large number of concepts, and (b) the amount of available activation is typically assumed to be limited (e.g., Anderson, 1983), it is quite implausible (and anything but parsimonious) to assume that a spread of activation from one concept to all other concepts with shared valence can have a measurable effect on target responding (e.g., Spruyt, Hermans, De Houwer, Vandromme, et al., 2007; but see below). A similar problem arises when one tries to explain the affective priming effect in terms of a distributed memory model (see Spruyt, Hermans, De Houwer, Vandromme, et al., 2007). For these reasons, there is now general consensus that affective priming effects, at least in the classic evaluative categorization task, are best explained in terms of processes that operate at the response selection stage.

Irrelevant S-R compatibility models.

Several authors have pointed out that, at the structural level, the traditional affective priming paradigm is quite similar to traditional irrelevant S-R compatibility tasks (e.g., De Houwer, 2003; Klauer et al., 1997; see also Chapter 4, this volume). Consider for example, the Stroop task (Stroop, 1935). In this task, participants are asked to name the ink color in which a word is written. On some trials, the word is compatible with the ink color (e.g., the word *red* written in red ink), whereas on other trials the word is incompatible with the ink color (e.g., the word *green* written in red ink). Crucially, variations in the compatibility of the task-irrelevant stimulus dimension (the color word) and the correct response are perfectly confounded with variations in the compatibility of the task-irrelevant stimulus dimension (the color word) and the task-relevant stimulus dimension (the ink color) (De Houwer, 2003). That is, whenever the word and the color are compatible (e.g., the word *red* written in red ink), the

correct response is also compatible with the irrelevant word meaning. Conversely, whenever the word and the color are incompatible (e.g., the word *red* written in green ink), the correct response is also incompatible with the irrelevant word meaning. Accordingly, the Stroop effect can be explained by assuming that the task-irrelevant word meaning automatically activates the corresponding response alternative (see Cohen, Dunbar, & McClelland, 1990; MacLeod, 1991).

In the traditional evaluative categorization task, it is possible to identify a similar pattern of overlap between the task-irrelevant and task-relevant stimulus dimension, on the one hand, and the task-irrelevant stimulus dimension and the required response, on the other hand. More specifically, whenever a prime is affectively related to a target (e.g., *terrific - friend*), its valence will also match with the response that is required (e.g., saying "positive"). Conversely, whenever a prime is affectively unrelated to a target (e.g., the prime *terrific - cancer*), there will be a mismatch with the response that is required (e.g., saying "negative"). Therefore, if it is assumed that the primes automatically activate the response alternative that corresponds to their valence, performance is expected to be superior on affectively congruent trials as compared to affectively incongruent trials, as is typically observed. In line with this reasoning, several variables known to affect the Stroop effect have been found to have similar effects on the affective priming effect in the evaluative categorization task (for an overview, see Spruyt, Hermans, De Houwer, Vandromme, et al., 2007).

The conception of the classic affective priming paradigm as an irrelevant S-R task is now generally accepted. It should be noted, however, that variations in irrelevant S-R compatibility can also underlie sequential priming effects in research domains other than affective priming. Consider, for example, the studies of Dehaene and colleagues on number processing (Dehaene et al. 1998). They asked participants to categorize target numerals as larger or smaller than 5. Unknown to the participants, each target numeral was preceded by a

masked prime numeral ranging from 1 to 9. Results showed that participants were faster to respond on compatible trials (both numerals fell on the same side of 5) as compared to incompatible trials (one numeral being larger than 5, and the other being smaller). Consistent with the idea that variations in irrelevant S-R compatibility can contribute to sequential priming effects whenever there is dimensional overlap between the response set and the irrelevant stimulus set, ERP and fMRI data collected by Dehaene et al. (1998) clearly showed prime-induced motor activity.

Nuts and Bolts

Although the sequential priming paradigm is in principle a very simple research paradigm, researchers who plan to conduct a sequential priming study for the first time are typically confronted with a multitude of procedural options to choose from. In this section, we will highlight some important issues that should be taken into account when setting up a sequential priming study. For a more exhaustive review of different procedural options we refer the reader to Wentura and Degner (2010).

Automatic versus non-automatic processes

Many researchers justify their use of the sequential priming paradigm by arguing that sequential priming effects reflect “automatic processes”. It is important to realize, however, that automaticity is an umbrella term for a number of features such as uncontrolled, unconscious, efficient, and fast (Moors & De Houwer, 2006; Moors et al., 2010). Put differently, it makes little sense to describe sequential priming effects as reflecting “automatic processes” without referring to individual automaticity features. Accordingly, we will structure our discussion of different procedural parameters in terms of different automaticity features.

Fast. In a typical sequential priming study, the prime stimuli are only presented for a very brief period of time (e.g., 150 ms) and are immediately followed by the target (Fazio et al., 1986; Hermans et al., 2001; Klauer et al., 1997; Spruyt, Hermans, De Houwer, Vandromme, et al., 2007). More specifically, the time interval between the start of the presentation of the prime stimuli and the start of the presentation of the target stimuli (i.e., Stimulus Onset Asynchrony, SOA) is typically not larger than 300 ms. The observation that sequential priming effects can be obtained at short SOAs is important theoretically because it suggests that the activation of memory representations by the primes (Process I) as well as the translation of this activation into an observable priming effect (Process II) can proceed very quickly. As pointed out by Moors et al. (2010), however, such a conclusion is valid only if response latencies are reasonably short. Assume, for example, that participants intentionally delay their responses in order to have more time to strategically evaluate the prime-target relationship. In that case, sequential priming effects do not reflect fast-acting processes after all, no matter how short the SOA is. It might therefore be a good strategy to implement a relatively early response deadline (e.g., Moors et al., 2010; Moors, De Houwer, Hermans, & Eelen, 2005).

Unconscious. At the most abstract level, the term unconscious can be used as a predicate of several things (Moors et al., 2010). Participants can be unaware of (a) the (perceptual or cognitive) input of a process, (b) the output of a process, and/or (c) the process itself (Bargh, 1994). Turning to the case of sequential priming, both Process I and Process II can be analyzed in these terms. For example, one might examine whether Process II requires consciousness of its input (i.e., the output of Process I). In practice, however, virtually all published studies on so-called “unconscious” or “subliminal” sequential priming were primarily designed to examine whether prime processing requires conscious identification of the instigating stimulus (e.g., a hypothesis concerning the input of Process I). For that reason,

we will limit our discussion of the automaticity feature ‘unconscious’ to this specific research question.

To prevent conscious identification or detection of the prime stimuli, it is typically recommended to rely on masked prime presentations (e.g., Holender, 1986). That is, the prime stimuli are presented for a very brief period of time (usually in the order of just tens of ms) and are followed (and often also preceded) by a pattern mask. The target is then presented and participants respond to the targets as fast as possible. If it is certain that a given masking procedure prevents conscious identification of the primes, finding a sequential priming effect strongly suggests that Process I is not critically dependent upon prime awareness.

The question is, however, how certain can one be? One strategy to deal with this problem is to establish individual awareness thresholds in a separate phase prior to the actual administration of the sequential priming procedure (e.g., Dagenbach et al., 1989; Hines, Czerwinski, Sawyer, & Dwyer, 1986; McNamara, 2005). Several issues need to be taken into account when turning to this solution. First of all, it is crucial that the procedural parameters used during the awareness assessment phase of the experiment and those used during the actual priming phase of the experiment are identical. It is well known, for example, that briefly presented primes are better identified when followed by semantically related targets than when followed by semantically unrelated targets (McNamara, 2005). An awareness assessment phase in which only unrelated targets (or no targets at all) are presented would thus almost certainly lead to an overestimation of individual awareness thresholds. Second, individual thresholds may decrease during the course of the actual experiment (Holender, 1986). As a result, primes thought to be presented below individual awareness thresholds may actually be presented above individual awareness thresholds later on in the experiment, at least on some trials (McNamara, 2005). Finally, demonstrating the absence of prime

awareness requires one to accept the null hypothesis, which is statistically problematic (e.g., Klauer & Greenwald, 2000; Rouder, Morey, Speckman, & Pratte, 2007).

An elegant way to deal with these complexities is to make use of the regression technique proposed by Greenwald and colleagues (e.g., Draine & Greenwald, 1998; Greenwald, Draine, & Abrams, 1996; Greenwald, Klinger, & Liu, 1989; Greenwald et al. 1995; Klauer & Greenwald, 2000; for other solutions see Dagenbach et al., 1989; Hirshman & Durante, 1992). When this technique is used, ostensibly unconscious sequential priming effects are regressed onto independent measures of prime awareness. One could, for example, regress affective priming effects obtained with briefly presented prime stimuli onto a signal detection measure of prime awareness (*d'*) obtained under the same presentation conditions at the end of the experiment (e.g., Klinger et al., 2000). If such an analysis reveals a significant intercept, one can conclude that the affective priming effect is significantly larger than zero even when prime awareness is at zero sensitivity. Note that the regression approach capitalizes on between-subject variability in the prime awareness measure to examine the functional relationship between sequential priming and prime awareness. It is therefore no longer problematic that prime stimuli are sometimes presented above individual thresholds. Moreover, because one can test for significance of the regression intercept, the regression approach also circumvents the problem of accepting the null-hypothesis. Nevertheless, the regression approach has also been criticized for a number of reasons. For an overview of these criticisms, see Dosher (1998), Merikle and Reingold (1998), Miller (2000), and Rouder et al. (2007).

Uncontrolled. The automaticity feature 'uncontrolled' is undoubtedly the most complex and the most critical one. As pointed out by Moors and De Houwer (2006) and Moors et al. (2010), to say that a process is uncontrolled is to say that this process is engaged in, stopped, altered, or avoided despite the fact that the goal to realize these effects is either

absent or at least not causally responsible for their occurrence. To what extent can one be certain that sequential priming effects reflect the operation of uncontrolled processes? On the one hand, one might argue that sequential priming effects must be due to uncontrolled processes simply because the primes are (by definition) task-irrelevant. For example, why would participants engage in intentional prime processing if doing so is completely irrelevant or even counterproductive for the task at hand? On the other hand, one must always be on the lookout for the operation of controlled processes, especially when the sequential priming paradigm is used to assess individual differences in socially sensitive domains such as stereotypes (e.g., Fazio et al., 1995), implicit self-esteem (e.g., Vandromme et al., in press), and political attitudes (e.g., Payne, Cheng, Govorun, & Stewart, 2005).

To minimize the likelihood that controlled processes contribute to the occurrence, size, or nature of the sequential priming effect, the following measures can be undertaken. First of all, one might implement a masked priming procedure (see above) to hinder the implementation of a conscious goal to process the prime stimuli (i.e., control over Process I). Consider for example, the studies of Degner and Wentura (2009). They examined automatically activated attitudes towards overweight and normal-weight persons using an affective priming procedure in which portrait pictures of normal-weight and overweight women were used as primes. Despite the fact that the prime stimuli were masked and were presented for just 24 ms, Degner and Wentura (2009) found priming effects to depend on the BMI of their participants. Given the presentation parameters implemented, it seems hard to imagine that this finding would be critically dependent upon the activation of an explicit intention to evaluate the prime stimuli. Nevertheless, it should be noted that the use of masked prime presentations does not rule out the possibility that sequential priming effects are dependent upon the activation of an unconscious goal (see Moors & De Houwer, 2006; Moors et al., 2010).

A second way to minimize the likelihood that controlled processes contribute to the occurrence or nature of the sequential priming effect is the use of a short SOA in combination with an early response deadline. If it is assumed that controlled processes are time-consuming (e.g., Moors & De Houwer, 2006), forcing participants to respond relatively quickly after the start of the presentation of the primes might indeed be sufficient to prevent the operation of controlled processes (e.g., Hermans et al., 2001). Note that this reasoning applies both to Process I and Process II. To illustrate this for Process II, consider the findings of Degner (2009). In a series of affective priming studies, Degner (2009) demonstrated that participants can strategically reduce or enhance the size of the affective priming, even at short SOAs. When participants were required to respond within 600 ms after target onset, however, attempts to strategically reduce affective priming effects were found to be ineffective.

Note, however, that the primes in the studies of Degner (2009) were completely uninformative about what the correct response was on each trial. That is, the probability that a specific prime stimulus would be followed by a target stimulus of the same valence was always identical to the probability that it would be followed by a target stimulus of the opposite valence. Findings obtained by Klauer and Teige-Mocigemba (2007) suggest that the use of a short SOA in combination with an early response deadline might not be sufficient to rule out subject strategies if the primes are predictive of the upcoming target. In their Experiment 1, participants completed a standard affective priming task in which just two positive and two negative pictures were used as primes. Whereas one positive and one negative prime picture were followed by a target of the same valence on most of the trials (i.e., non-shift primes), the two other prime picture were mostly followed by a target of the opposite valence (i.e., shift primes). Crucially, participants in the experimental group were informed about these contingencies and they were told to rely on this knowledge to maximize performance. Despite the use of a 275-ms SOA and a response deadline of just 800 ms, shift

primes were found to produce reversed priming effects whereas non-shift primes produced standard, assimilative priming effects. This finding suggests that participants in the experimental group were able to use the expectation that shift primes would often be followed by a target of the opposite valence. Most researchers will agree, however, that using a short SOA in combination with an early response deadline at least minimizes the likelihood that sequential priming effects are due to strategic expectancy generation.

A final procedural parameter that may determine the extent to which sequential priming effects reflect controlled processes is the nature of the response task. Consider again the case of affective priming. In the standard version of this paradigm, participants are explicitly asked to evaluate the target stimuli in terms of their affective connotation. If these instructions trigger the goal to evaluate stimuli in general, including the prime stimuli, attitude activation by the primes (Process I) must be labeled as intentional. Alternatively, if attitude activation is dependent upon the explicit goal to evaluate the targets without the intermediate goal to evaluate all stimuli in general or even the prime stimuli in particular, attitude activation by the primes can be labeled as goal-dependent but unintentional (Moors et al., 2010). Note that a similar reasoning can be applied to all sequential priming tasks that capitalize on variations in irrelevant S-R compatibility. Reconsider, for example, the studies on unconscious number priming by Dehaene et al. (1998; see also Koechlin, Naccache, Block, & Dehaene., 1999). If number priming is critically dependent upon the goal to classify target stimuli as larger or smaller than 5, unconscious prime processing can be labeled as (a) goal-dependent but unintentional or (b) intentional, depending on whether participants have the intermediate goal to process numbers in general or not.

To rule out goal-dependent unintentional or even intentional prime processing, one can implement a response task that does not require an explicit evaluation of the target stimuli. Probably the best-known example of such a task is the naming task. The biggest advantage of

this response task is that it is in a sense semantically neutral (Spruyt et al., 2009). That is, it does not induce a particular processing mindset. This is important because recent studies conducted at our lab suggest that the (semantic) analysis of prime stimuli (Process I) depends heavily on the extent to which participants assign attention to specific stimulus dimensions of the target stimuli. The more participants focus their attention on one particular stimulus dimension of the target stimuli (e.g., the affective stimulus dimension), the more likely they will process the same dimension of the (task-irrelevant) prime stimuli too. At the same time, however, it becomes less likely that other prime dimensions will be processed. It is thus important that attempts to rule out a processing mindset that promotes the analysis of one particular stimulus dimension (e.g., stimulus valence) do not result in the induction of another mindset that actually hinders the analysis of that stimulus dimension (e.g., an animacy judgment task, Klinger et al. 2000, see below). Using a naming task circumvents such a problem, although it is true that sequential priming effects tend to be less reliable in a naming task than in a sequential priming task that capitalizes on irrelevant S-R compatibility effects (e.g., the evaluative decision task).

Finally, it should be noted that even in the naming task subtle procedural aspects can affect the extent to which participants assign attention to specific stimulus dimensions. As an illustration, consider the findings of Everaert, Spruyt, and De Houwer (2010). They examined whether affective priming in the naming task depends on the proportion of stimuli that have a clear affective connotation. In one group of participants, experimental trials were embedded in a context of filler trials that consisted of affectively polarized stimulus materials (i.e., high valence proportion condition). In a second group, the same set of experimental trials was embedded in a context of filler trials consisting of neutral stimuli (i.e., low valence proportion condition). Results showed that the affective priming effect was reliable in the high valence proportion condition only. This list-context effect demonstrates that even subtle aspects of an

experimental procedure can have an impact on feature-specific attention allocation.

Efficient. A process can be qualified as efficient if it does not depend on attentional deployment. As pointed out by Moors et al. (2010) and Moors and De Houwer (2006), this general definition may refer to two different aspects of attention: quantity and direction. The first aspect refers to the amount of attentional capacity that is required for a process to take place. The second aspect refers to the direction of attention, regardless of whether a small or large quantity of that attention is required.

Let us first discuss the quantity aspect. To examine whether sequential priming effects depend on the quantity of attentional capacity, researchers typically rely on dual-task methodology. The rationale behind this practice is straightforward. If processes underlying a sequential priming effect are efficient, having to perform a secondary task should not interfere with its occurrence. As an example, consider the findings of Hermans et al. (2000). They asked participant to perform a standard affective priming task while reciting a series of digits. Crucially, the extent to which the memory load task depleted cognitive resources was manipulated over three levels: Participants either recited (a) no digits at all, (b) a simple series of alternating digits (e.g., 6 9 6 9 6 9), or (c) a complex series of 6 digits (e.g., 1 3 5 7 9 1). Consistent with the hypothesis that the affective priming effect is based on efficient processes, Hermans et al. (2000) found the affective priming effect to be unaffected by the mental load manipulation. It should be noted, however, that Klauer and Teige-Mocigemba (2007) found participants low in working memory capacity to show larger affective priming effects under (high) memory load conditions. This finding suggests that participants try to counteract the influence of the primes but fail to do so when cognitive capacity is chronically low and depleted at the same time. It is therefore always a good research strategy to implement an individual difference measure of working memory capacity when examining the efficiency of processes that underlie sequential priming effects (for details of the measurement of working

memory capacity, see Chapter 7, this volume).

The second aspect of the automaticity feature ‘efficiency’ concerns the direction of attention, regardless of whether a small or large quantity of that attention is required. We already discussed the finding that feature-specific attention allocation can have a strong impact on the (semantic) analysis of the prime stimuli. There is also evidence showing that sequential priming effects depend on temporal and spatial attention (Kouider & Dehaene, 2007). For example, in two event related potentials (ERP) studies, Kiefer and Brendel (2006) found masked semantic priming (N400 modulation) to be significantly reduced when the primes did not appear at temporally predictable moments (see also Naccache, Blandin, & Dehaene, 2002). In the domain of spatial attention, the impact of selective attention on the semantic priming effect was convincingly established, among others, by Musch and Klauer (2001). They presented primes and targets at different locations of a computer screen and found semantic priming only if locational uncertainty about the target location required participants to distribute their attention across different locations. If certainty about the target location induced focused spatial attention, semantic priming vanished completely (see also Lachter, Forster, & Ruthruff, 2004).

S-S compatibility versus irrelevant S-R compatibility

Typically, sequential priming effects that result from variations in irrelevant S-R compatibility are more robust than sequential priming effects that result from S-S compatibility. Consider, for instance, the case of affective priming. Whereas the affective priming effect is a highly robust and replicable phenomenon in the evaluative decision task, affective priming effects that are obtained with the naming task are typically small and sometimes even fail to reach significance (e.g., Klauer & Musch, 2001; Spruyt, Hermans, Pandelaere, De Houwer, & Eelen, 2004). As explained above, both tasks are, despite their similarity at the procedural level, fundamentally different if one considers the underlying

processes that drive the affective priming effect. Whereas the evaluative categorization task capitalizes both on S-S and irrelevant S-R compatibility effects (De Houwer, 2003), the naming task is a prototypical example of a pure S-S compatibility task. In the traditional semantic priming literature it is also often found that sequential priming effects are much less reliable if participants are asked to name the target stimuli (e.g., Hodgson, 1991; Neely, 1991). Therefore, if there are no theoretical reasons to use a pure measure of S-S compatibility, it is always a good strategy to rely on sequential priming procedures that capitalize on S-R compatibility effects. Conversely, the hypothesis that variations in S-S compatibility contribute to a given sequential priming effect can never be tested using a sequential priming paradigm that comprises an irrelevant S-R component.

Process hierarchy and inferential confounds

Because sequential priming effects always require two sequential steps to come about (i.e., Process-I followed by Process-II, see above), one can never be sure what to conclude when null-findings are observed (even if one can rule out a statistical Type-II error). What does it mean if some sort of prime-target relationship produces no priming in a given response task? A likely possibility always is that the primes, in spite of being fully processed, fail to exert an influence on target responding (i.e., a Process-II explanation). Equally likely, however, is the hypothesis that the primes (or certain features thereof) are simply not processed under the conditions implemented a (Process-I explanation). If null-findings emerge under certain conditions, both possibilities should therefore be considered so as to avoid inferential confounds. To demonstrate the importance of this issue, consider the case of affective priming of non-affective semantic categorization responses. In an attempt to shed light on the processes that underlie affective priming, several researchers have examined whether the affective priming effect can be replicated if participants classify (positive and negative) target stimuli into non-affective semantic categories (e.g., objects versus persons).

In each of these studies, participants either performed the traditional evaluative decision task or a non-affective semantic categorization task. Significant affective priming effects were readily obtained with the evaluative decision task, whereas null-findings were found in the non-affective semantic categorization task (e.g., De Houwer, Hermans, Rothermund, & Wentura, 2002; Klinger et al., 2000; see also Klauer & Musch, 2002). Variations in irrelevant S-R compatibility cannot contribute to the affective priming effect in the non-affective semantic categorization task (i.e., there is no dimensional overlap between the prime set and the response set). Therefore, several researchers interpreted this data pattern as supporting evidence for the hypothesis that affective priming effects are driven only by processes that operate at the response selection stage (i.e., a Process-II explanation). This conclusion was based on the implicit assumption, however, that (evaluative) prime processing is identical in both tasks. Recent studies revealed that this assumption was incorrect. Spruyt et al. (2009; see also Spruyt, De Houwer, et al., 2007) demonstrated that (a) affective stimulus processing is strongly reduced if participants are required to assign selective attention to non-affective stimulus features, and (b) affective priming effects can be replicated in the non-affective semantic categorization task too, provided that participants are encouraged to assign attention to the affective stimulus dimension. In other words, failures to replicate the affective priming effect in non-affective semantic categorization tasks should be attributed to reduced evaluative (prime) processing (i.e., a Process-I explanation) rather than to the fact that variations in irrelevant S-R compatibility cannot contribute to the effect in this task (i.e., a Process-II explanation). In other lines of research too, researchers should always be on the lookout for such a confound between Process-I and Process-II explanations.

Reliability of sequential priming measures

One of the most interesting and promising developments over the past few years has been the use of the sequential priming paradigm as tool to asses individual differences and the use of idiosyncratic priming effects as predictors of behavior. The viability if this practice is weighed down, however, by the fact that the reliability of sequential priming measures is (typically) unsatisfactory low. Consider, for instance, the findings of Bosson, Swann, and Pennebaker (2000). They found test-retest reliabilities of .08 and .28 for a supraliminal and a subliminal priming measure of (automatically activated) self-esteem, respectively. Similarly, Banse (2001) reported very low split-half reliability estimates for their priming measures of automatically activated attitudes towards liked and disliked persons. In the non-affective domain, Stolz, Besner, and Carr (2005) also reported very low reliability estimates for the semantic priming effect. If one takes these findings seriously, it must be concluded that sequential priming measures of individual differences currently enjoy a popularity that is not justified by their psychometric properties.

Although systematic research on this topic is currently missing, the literature suggests several strategies that might help to improve the reliability of sequential priming measures. First of all, we suspect that the reliability of sequential priming measures may depend on the extent to which spontaneous shifts in feature-specific attention allocation are controlled for. Recent evidence obtained by Gawronski, Cunningham, LeBel, and Deutsch (in press) is consistent with this hypothesis. To obtain individual measures of ageism an racism, they primed participants with Black and White faces of either young or old age in a standard affective priming task (i.e., the evaluative categorization task). Crucially, Gawronski et al. (in press) manipulated feature-specific attention allocation by asking participants to keep a mental tally of either (a) how many Black versus White individuals were presented over the course of the task (i.e., selective attention for race) or (b) how many young versus old

individuals were presented during the task (i.e., selective attention for age). Results showed that reliability estimates of the ageism and racism scores (i.e., odd-even split-half correlations) were clearly affected by this manipulation of feature-specific attention allocation. That is, racism scores were found to be more reliable when participants paid attention to race than when they paid attention to age whereas ageism scores were found to be higher when participants paid attention to age than when they paid attention to race. Moreover, both ageism and racism scores were found to correlate with corresponding self-reported category evaluations only when participants were asked to pay attention to these categories in the sequential priming task. Taken together with our own work on the impact of feature-specific attention allocation on sequential priming (e.g., Spruyt et al., 2009; see above), these findings strongly suggest that controlling for spontaneous shifts in feature-specific attention allocation might be a good strategy to improve the reliability of sequential priming measures.

Second, it is well-known that sequential priming effects can be affected by list-context effects as well as the sequential order of individual priming trials. As an example of a list-context effect, consider the findings of Klauer et al. (1997; see also Spruyt, Hermans, De Houwer, Vandromme, et al., 2007). They demonstrated that the size of the affective priming effect in the standard evaluative categorization task is critically dependent upon the number of affectively congruent trials, even at short SOAs (i.e., 0 and 200 ms). More specifically, they found that the magnitude of the affective priming effect increases with increasing proportions of affectively congruent trials (i.e., consistency proportion, CP). In a similar fashion, Klauer, Mierke, & Musch (2003) demonstrated that affective priming effects depend on the proportion of positive relative to negative targets (hereinafter referred to as *the positivity proportion effect*): The larger the positivity proportion, the larger the impact of negative primes, and vice versa.

As an example of a sequential-order effect, consider the affective priming studies by Wentura (1999). He demonstrated that the time needed to evaluate a target on trial *n* increases when the valence of that target matches with the valence of an incongruent prime on trial *n*-1. This finding suggests that a response conflict on trial *n*-1 results in a suppression of the response alternative that is trigged by the prime. If the information that was irrelevant on trial *n-1* is then relevant on trial *n*, this inhibition needs to be overcome and responses will be delayed. Similar sequential effects have also been reported, among others, by Greenwald et al. (1996) and Klauer, Teige-Mocigemba, and Spruyt (2009).

In principle, these list-context effects and sequential-order effects are all orthogonal to the individual differences that one seeks to measure using a particular sequential priming procedure. It can therefore be hypothesized that they can potentially compromise the reliability of sequential priming measures. Researchers using the sequential priming paradigm to measure individual difference are therefore advised to control for such effects. For example, if the affective priming paradigm is used to obtain individual difference measures of automatically activated attitudes, the positivity proportion should definitely be set to .50.

It is important to emphasize, however, that the extent to which sequential priming measures are affected by list-context effects and/or sequential-order effects effect is probably dependent upon on the nature of the response task and, hence, the nature of the processes that underlie a particular sequential priming effect. Take, for instance, the positivity proportion effect described above. As pointed out by Klauer et al. (2003), this effect is best explained in terms of an attentional bias favoring the rare kind of valence. It seems reasonable to assume that such a bias will not occur if participants are not required to respond on the basis of the valence of the targets. A similar analysis can be applied to the CP effect reported by Klauer et al. (1997). To account for this effect, Klauer et al. (1997) suggested that participants (a) strategically divide their attention between the primes and the targets and (b) assign greater

attentional weights to the primes when they learn that the CP is above or below chance level. Such a mechanism can be effective only if there is dimensional overlap between the prime set and the response set. One would therefore expect CP effects to be absent in a response task that doesn't capitalize on variations in irrelevant S-R compatibility. In line with this reasoning, Spruyt, Hermans, De Houwer, Vandekerckhove, et al. (2007) indeed found that the CP does not affect the affective priming effect if participants are asked to name the targets instead of categorizing them. Taken together, these findings suggest that it could be worthwhile to rely on sequential priming tasks that capitalize on S-S compatibility effects rather than on irrelevant S-R effects if one wants to capture individual differences. More research is needed, however, to substantiate the viability of this hypothesis.

Example

To illustrate the use of the sequential priming paradigm in more detail, consider the studies of Spruyt, Hermans, De Houwer, Vandekerckhove, et al. (2007). They tried to predict participants' choice between an apple and a Snickers on the basis of idiosyncratic affective priming scores. Crucially, Spruyt and his colleagues administered two different versions of the affective priming paradigm: a classic evaluative decision task and a naming task. The motivation for including the naming task next to the evaluative decision task was twofold. First of all, because the naming task does not rely on a normative (explicit) classification of the target stimuli, Spruyt, Hermans, De Houwer, Vandekerckhove, et al. (2007) hypothesized that the naming task might be insensitive to so-called extra-personal associations – associations that, although available in memory, are irrelevant to one's evaluation of a particular attitude object (e.g., societal views; see Olson & Fazio, 2004, p. 663). Second, Spruyt, Hermans, De Houwer, Vandekerckhove, et al. (2007) hypothesized that list-context effects and/or sequential-order effects are more likely to interfere with target responding in a

irrelevant S-R task (i.e., the evaluative categorization task) as compared to a S-S task (i.e., the naming task). Spruyt and his colleagues therefore expected individual difference measures obtained with the naming task to provide a more unbiased estimate of an individual's attitude towards the prime objects than the standard evaluative categorization task.

Except for the nature of response task, both priming tasks were identical. The prime set consisted of (a) four photographs of various kinds of fruit (including an apple), (b) four photographs of various candy bars (including a Snickers), and (c) four neutral prime stimuli (e.g., a white rectangle on a blue background). The target set consisted of 4 positive and 4 negative photographs. The prime pictures were presented for 200 ms and were followed by the targets after an inter stimulus interval of 50 ms (SOA 250). The targets were presented until a response was detected or 2000 ms elapsed. Note that participants completed two series of practice trials in the naming task to ensure that they would all use the same set of verbal responses (i.e., 'corpse', 'explosion', 'garbage', 'skulls', 'baby', 'bride', 'dolphin', 'kitten'). Also note that both the prime set and the target set consisted of pictures instead of words. The choice for a picture – picture paradigm was motivated by the fact that affective priming of naming responses is typically more reliable in a picture – picture paradigm as compared to a word – word paradigm (Spruyt et al., 2002; Wentura & Frings, 2008), possibly because of salience-induced selective attention for the affective stimulus dimension (see above).

The findings of Spruyt, Hermans, De Houwer, Vandekerckhove, et al. (2007) were clear-cut. Affective priming effects obtained with the naming task were clearly related to participants' choice behavior. Participants who tended to respond faster (slower) on candy/positive (candy/negative) trials relative to apple/positive (apple/negative) trials also tended to chose a Snickers over an apple. Moreover, affective priming scores obtained with the naming task were found to be predictive of participants' choice behavior over and above questionnaire measures. In contrast, affective priming effects obtained with the evaluative

task were completely unrelated to participants' choice behavior.

This data pattern is interesting for several reasons. First of all, the mere observation that priming measures of (automatic) attitude activation can be used to predict behavior corroborates the idea that the sequential priming paradigm can be exploited as an individual differences measure. Second, the observation that affective priming scores can predict behavior over and above self-report measures strongly suggests that the sequential priming paradigm can be used to capture traces of past experience that (a) participants are unwilling to reveal (e.g., Fazio & Olson, 2003) or (b) are introspectively unidentified (Banaji & Greenwald, 1994; Greenwald, 1990; Greenwald & Banaji, 1995; Olson & Fazio, 2003; Wilson, Lindsey, & Schooler, 2000). Finally, the findings of Spruyt, Hermans, De Houwer, Vandekerckhove, et al. (2007) also underscore the importance of taking into account the structural characteristics of a sequential priming paradigm. At a superficial level, the naming task and the evaluative categorization task are quite similar. Yet, at the Process-II level, they are completely different (see above). Consistent with this analysis, the predictive validity of both tasks was found to be quite different.

Discussion

Over the last 50 years, the sequential priming paradigm has become one of the most frequently used cognitive research paradigms. The reasons for its popularity are straightforward. First of all, the sequential priming paradigm is relatively easy to implement. To be sure, given the large amount of procedural parameters (SOA, prime duration, stimulus modality, etc.), it can sometimes be difficult to select the most appropriate procedure for a particular research goal. However, once it is clear how a sequential priming procedure should look like, it is typically not very difficult to implement it. For that reason, we decided to structure our discussion of different procedural options in terms of theoretically relevant

issues (e.g., features of automaticity) rather than in terms of different procedural parameters. A second reason for the popularity of the sequential priming paradigm is undoubtedly its flexibility. We have demonstrated that the sequential priming paradigm can be used to evaluate a wide range hypotheses. Moreover, the range of stimulus materials that one can use is virtually unlimited. In the case of affective priming, for example, sequential priming effects have been obtained with stimulus materials as diverse as words (e.g., Fazio et al., 1986), line drawings (e.g., Giner-Sorolla, Garcia, & Bargh, 1999), complex color pictures (e.g., Hermans et al., 1994), odors (e.g., Hermans, Baeyens, & Eelen, 1998), and musical chords (e.g., Sollberger, Reber, & Eckstein, 2003). Accordingly, the sequential priming paradigm has become a common research tool in different research domains and we are certain that researchers will continue to use it in the future.

One of the most interesting and promising developments over the past few years has been the use of the sequential priming paradigm as tool to asses individual differences and the use of idiosyncratic priming effects as predictors of behavior. The studies by Spruyt, Hermans, De Houwer, Vandekerckhove, et al. (2007) on consumer choice behavior are one example of such a line of research. Many more examples can be found in the domain of automatically activated racial attitudes (e.g., Fazio et al., 1995; Fazio & Olson, 2003), experimental psychopathology (e.g., Hermans et al., in press; Meites, Deveney, Steele, Holmes, & Pizzagalli, 2008), and implicit self-esteem (e.g., Vandromme et al., in press). As already argued above, however, that the viability of this practice is weighed down by the poor psychometric qualities of sequential priming measures. Research aimed at improving the psychometric quality of sequential priming measures is therefore desperately needed.

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Footnotes

[1] Even if it is assumed that Process II can set in before Process I is completely finished, it remains true that partial completion of Process I must precede the initiation of Process II (see Moors et al., 2010, Footnote 3).

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