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# Situated conceptualization offers a theoretical account of social priming

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The theory of situated conceptualization is introduced, including its core assumptions about the construction and storage of situated conceptualizations, the production of pattern completion inferences in relevant situations, and the implementation of these inferences via multimodal simulation. The broad applicability of the theory to many phenomena is reviewed, as is its ability to explain individual differences. The theory is then applied to social priming, showing that the theory provides a natural account of the diverse forms it takes. The theory also explains why social priming is difficult to define, why it often reflects modulating factors, and why it can be difficult to replicate. The importance of studying pattern completion inferences in the context of meaningful situated action receives emphasis.

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**Current Opinion in Psychology** 2016, 12:6–11

This review comes from a themed issue on **Social priming**

Edited by **Fritz Strack** and **Norbert Schwarz**

<http://dx.doi.org/10.1016/j.copsyc.2016.04.009>

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## The theory of situated conceptualization

The construct of situated conceptualization developed originally to explain how simulations of conceptual knowledge become situated [1–5]. The construct was also used initially to explain social embodiment effects, a form of social priming [6]. Recently, situated conceptualization has been developed as a more general theoretical framework that underlies perception, action, cognition, social cognition, affective processing, and appetitive processing [7]. After presenting the three basic constructs of the theory — situated conceptualization, pattern completion inference, and multimodal simulation — it is applied to social priming.

### Situated conceptualization

A central premise of the situated conceptualization framework is that the brain is a situated processing architecture, designed to process situations in the moment and to

simulate non-present situations in thought [1–7]. As a person perceives, cognizes, and acts in the current situation (e.g. a coffeehouse), multiple neural systems process different situational elements in parallel, generating complementary streams of information about the situation. Specifically, different neural systems process the current setting (parietal lobe, parahippocampal gyrus, retrosplenial cortex), objects in the setting (the ventral stream), other agents who are present (temporal poles, FFA, mPFC, PCC, STG, EBA), self conceptions and self relevance (mPFC, PCC), physical actions in the environment (motor and somatosensory cortices, cerebellum, basal ganglia), and a wide variety of mentalizing, affective, and interoceptive responses to the situation (mPFC, OFC, IPFC, ACC, insula, amygdala, PCC).

Over time, each of these neural systems produces a continuous stream of perceptual experiences (qualia) for its respective situational content, along with corresponding conceptual interpretations. While in a coffeehouse, for example, the neural system that processes the setting produces a continuous stream of perceptual and conceptual information about it. As each system processes its respective situational information, association areas integrate these streams of ‘local’ information ‘globally’ [7,8]. As a result of this integration, a coherent perceptual experience of the situation results, along with a coherent conceptual interpretation of the complex events occurring (e.g. the perceptual experience of being in a coffee house; the conceptual interpretation of drinking coffee). Together, the coherent perceptual experience and conceptual interpretation constitute a *situated conceptualization*.

As a situated conceptualization is constructed, associative mechanisms establish a statistical trace of it in long-term memory. If a particular type of situation occurs repeatedly, the situated conceptualizations that result might become integrated into a category of exemplars that represents this situation [9,10]. Alternatively, these different situated conceptualizations could be superimposed onto a common network, such that their aggregate effects on network weights represent the category. To the extent that the network includes hidden units for capturing correlations between local situation elements, it becomes possible to statistically maintain information about specific exemplars ([11], also see [12]).

### Pattern completion inference

When an element of an earlier situation is encountered on a later occasion, it may activate a situated conceptualization

stored previously in a Bayesian manner [13]. On seeing a new coffee house in your neighborhood, for example, a situated conceptualization for a previous coffeehouse could become active that has either been experienced frequently (based on priors) or that is a good match with the locale (based on likelihoods). As the facade of the new coffeehouse is processed in its neighborhood context, it projects onto all situated conceptualizations in memory that share similar perceptual and conceptual content. Essentially, the brain attempts to categorize the situation currently being perceived. When the most likely and best matching situated conceptualization becomes active, it categorizes the current situation as a similar type of situation. On some occasions, the best fitting situated conceptualization might come from a category of familiar repeated situations; on others, it might come from a specific memory of a unique situation.

Based on the contributions of likelihoods to this process, the more features that a stored situated conceptualization shares with the current situation, the more likely it is that the situated conceptualization will become active. As we will see later, this matching assumption is useful in explaining problematic issues associated with social priming.

When the best-fitting situated conceptualization becomes active, its content is likely to vary from the content captured originally, reflecting changes in memory and reconstruction in the current context. As the reconstructed conceptualization becomes active, it produces inferences about what is likely to occur in the current situation. Based on the inferential process of pattern completion, content in the activated situated conceptualization that has not yet been perceived is inferred as likely to occur. On seeing the new coffeehouse, for example, the situated conceptualization that becomes active might produce inferences that the coffeehouse is likely to have tables, chairs, and coffee inside, that people are likely to be talking, reading, and working, and that the atmosphere is likely to be friendly, cerebral, and hip. Typically, these inferences occur involuntarily as the situated conceptualization becomes active, with some of them being conscious and others being unconscious.

Two important properties of this process are, first, any aspect of a situation can activate a situated conceptualization, and, second, any aspect of a situated conceptualization can be inferred as a pattern completion inference. Imagine, for example, that a situated conceptualization was established while hearing a someone sing a song at a New Year's Eve party. On later revisiting the party setting, the setting could reactivate the situated conceptualization and produce a memory of the song as a pattern completion inference, or it could produce any other aspect of the party (e.g. the people present). Conversely, later hearing the song on the radio could activate the same situated conceptualization, producing the setting for the party as a pattern

completion inference, or again any other aspect of the event. In general, any feature of a situated conceptualization, when encountered later, can activate the situated conceptualization and produce its other features as inferences. The dynamic flexibility of pattern completion inferences will also play important roles later in explaining problematic issues associated with social priming.

### Multimodal simulation

Finally, the situated conceptualization framework assumes that pattern completion inferences are typically implemented as multimodal simulations [4,7,14,15]. On seeing a new coffeehouse, for example, the inferences that it contains tables, chairs, and coffee are likely to be implemented by reenacting brain states previously experienced for perceiving these objects [16]. Analogously, inferences that people will be talking, reading, and working are likely to be implemented by reenacting brain states previously associated with performing these activities [17], and inferences about more abstract qualities of the situation are likely to be implemented by reenacting brain states associated with experiencing these qualities previously [8,18].

In this manner, activating a situated conceptualization related to the current situation partially reinstates the original situation in the brain's situation processing architecture. By reenacting the original situation, the pattern completion process provides a concrete sense of being in the situation physically, acting in it, and responding to it emotionally. By superimposing the simulated situated conceptualization on the current situation, the pattern completion process guides perception, action, and affective states as the situation unfolds.

### Applications

The situated conceptualization framework informs a broad variety of psychological phenomena [7]. For any phenomenon, a person's past situational experience affects the pattern completion inferences that they produce in new situations. In perception and action, for example, this framework helps explain object affordances and scene inferences. In cognition, this framework similarly helps explain the cuing of episodic memories, the production of comprehension inferences, and basic reasoning strategies. In social cognition, this approach helps explain social embodiment, social priming, and social mirroring. In affective science, this approach helps explain emotion and conditioning. In appetitive processes, this approach helps explain desire, habits, implementation intentions, and goal priming [19].

Finally, the situated conceptualization framework offers a natural account of individual differences across diverse phenomena [7,8,19,20]. To the extent that different individuals experience different kinds of situations related to a specific phenomenon, different populations of

situated conceptualizations accrue in their respective memories. If, for example, different individuals experience different kinds of eating situations, they accumulate different populations of situated conceptualizations for eating. As a consequence, these different populations produce different pattern completion inferences to food cues on later occasions. On seeing pizza, for example, people who often consume pizza generate pattern completion inferences that anticipate the taste, reward, actions associated with consuming it. Conversely, dieters who never eat pizza generate different pattern completion inferences, perhaps including the inhibition of taste and reward simulations, together with the activation of healthy eating goals. In a similar manner, individual differences arise across all the phenomena mentioned earlier, including affordances [21], mirroring [22], and emotion [8].

### Social priming as pattern completion inferences from situated conceptualizations

As many researchers have shown, just about any element of a social situation can prime some other aspect of the situation (for a recent review and discussion of findings, see the 2014 special issue of *Social Cognition* on social priming). For example, skin color, age, gender, and culture can prime traits and stereotypes. Inferred traits and perceived situations can prime expected actions of others. Foods, drinks, in-group members, and out-group members can prime one's own goals and actions. Bodily states, temperature, weight, cleanliness, color, and shape can prime evaluations and affect. On and on it goes across decades of research in social psychology, with just about any aspect of a social situation functioning as both a prime and a primed response.

The situated conceptualization framework offers a natural account of social priming and its ubiquitous character. As a person experiences social situations, situated conceptualizations of them are constructed. As these situated conceptualizations accumulate in memory, they offer extensive sources of pattern completion inferences on subsequent occasions. When one of their elements is encountered (e.g. skin color, gender, age), it activates a relevant situated conceptualization containing the element, producing remaining elements as pattern completion inferences, including evaluation, affect, action, and so forth. Because any aspect of these situated conceptualizations can trigger this process, or be the outcome of it, social priming takes infinitely many forms.

### Explaining the difficulty of defining social priming

As just implied, one reason it's difficult to define social priming is because any aspect of a social situation can be a prime or a primed response. The generality of this process suggests that social priming is not a meaningful category and should not be viewed as a coherent phenomenon [23].

A more important reason — from the theoretical perspective developed here — is that social priming is just another instance of pattern completion inferences from situated conceptualizations. As we saw earlier, pattern completion inferences do not just occur for social priming, but occur for virtually all cognitive, social, affective, and appetitive phenomena. In this regard, social priming is hardly unique but just one more instance of a basic cognitive process, perhaps one of the most basic in the brain [24]. From this perspective, it could be useful to forego the construct of social priming and focus on more meaningful mechanisms and phenomena [23].

### Explaining the frequent modulation of social priming

Researchers frequently report that social priming does not simply result via direct associations from perceptions to goals, emotions, and/or behaviors, but is often modulated by a host of other variables. Construals of self, others, and the current situation, for example, frequently contribute to specific goals and behaviors that are primed [25]. Many articles in the special issue of *Social Cognition* (2014) further document such modulation (e.g. [26]), with some articles focusing on specific modulators, including motivational significance [23], resource availability [27], self-concepts [28,29], and prime source [30].

The situated conceptualization framework offers a natural account of these modulatory effects, drawing on two of its basic assumptions [19,20,31]: first, when a social situation is experienced, all salient and relevant aspects of it are processed perceptually and conceptually, thereby becoming captured as elements of the situated conceptualization established in memory. Second, when a prime is encountered, it activates relevant situated conceptualizations, with the best-fitting one becoming active to guide processing of the current situation.

Together, these two assumptions naturally explain the modulation of social priming. When a prime is encountered, it is embedded in a current situation that contains a broad ensemble of situational elements. Not only does the prime project onto situated concept conceptualizations in memory, the prime *plus the entire ensemble of current situational elements* projects onto memory. Thus, the activation of the best fitting situated conceptualization not only reflects how well the prime matches stored situated conceptualizations, but how well the entire ensemble matches them. From this perspective, prime responses are more likely to occur when a prime is encountered in a familiar ensemble of situational elements than in an unfamiliar ensemble. Most importantly, all the kinds of modulators addressed in the social priming literature are obvious candidates for situational elements that become stored in situated conceptualizations, and whose presence or absence later modulates the activation of primed responses.

If this account is correct, the modulation issue is much more extreme than imagined previously, because virtually any element of a situation can modulate social priming, not just those noted so far in the literature. Many previous reviews have documented the exquisite sensitivity of cognition and behavior to the presence of detailed contextual information [5,19,31–33]. Thus, it should not be surprising that social priming reflects this exquisite sensitivity as well.

### Explaining the difficulty of replicating social priming

Based on the evolving social priming literature, it is fair to say that simple direct pathways from primes to primed responses rarely, if ever, exist. Instead, these pathways often appear to be modulated by a host of situational variables. An additional complicating factor is that once a situated conceptualization becomes active, additional factors adapt it to the current situation [34,35]. In the process, a primed response that becomes active as a pattern completion inference might be modified in some way, such that a novel response to the prime occurs.

According to the situated conceptualization framework, obtaining a robust social priming effect requires at least three enabling conditions. First, it is necessary that all, or at least many, participants have had similar situational experience with the prime and primed response, such that they have situated conceptualizations containing both in memory. Second, it is necessary that there be a high overlap between the situational elements encountered with the prime and the situational elements stored in the relevant situated conceptualizations. Third, it is necessary that the prime not be stored with other situated conceptualizations having different responses, which are more frequent and/or a better match to the current situation than situated conceptualizations containing the target primed response.

To the extent that any of these conditions is not met, a given participant may not produce a primed response of interest. Given the diverse situational experience that people have, both in the past and in the current moment, it seems likely that diverse responses to a prime will occur regularly.

### Reconceptualizing social priming

Common theoretical accounts of social priming assume that it results from spreading activation in semantic networks or in perception-action associations [36–38]. As we have seen, the extensive presence of modulating factors greatly complicates these accounts, requiring the presence of complex pathways between primes and primed responses. Perhaps a more serious problem is the implicit assumption that social priming paradigms test the structure of semantic networks and perception-action associations. From this perspective, if a social priming phenomenon is well understood, it should be possible

to present primes to a representational system and observe the predicted primed responses. In other words, the standard focus is on understanding what social priming tells us about the static structure of semantic networks and perception-action associations.

The situated conceptualization framework offers a very different way of thinking about social priming. From this perspective, social priming results from pattern completion inferences that underlie intelligent goal-directed behavior in general. More importantly, this approach assumes that the primary purpose of pattern completion inferences is to guide cognition, emotion, and behavior during meaningful situated action in the world [4,39]. Thus, when a situated conceptualization becomes active to process a current situation, it produces a package of anticipatory inferences — implemented as multimodal simulations — to support intelligent goal pursuit in the current environment. Possible inferences include perceptual anticipations of what is likely to occur, simulations of possible reward, potential actions that could be performed, likely outcomes that could result, and so forth. Rather than being the mechanical outputs of a detached semantic network, pattern completion inferences occur as a broad package of multimodal inferences that guide an agent's intelligent action in the current situation.

Furthermore, the situated conceptualization framework offers a principled account of the knowledge structures that develop to produce these packages of multimodal inferences. Every time a situation is experienced, the states of all systems active at the time in the brain's situation processing architecture are captured in memory as a situated conceptualization [1,4,7,14]. Rather than being stored as abstract symbolic propositions that describe these states, the actual states of these systems themselves are stored. On later occasions, when situational cues activate this situated conceptualization, they partially reactivate these states in a reconstructive manner, thereby implementing a multimodal simulation of the processing that occurred during the situation. From this perspective, social priming — and pattern completion inferences in general — reflect the reinstatement of previous situational activity, guiding current situational activity in the moment.

To the extent that previously-experienced situational elements are encountered in a current situation that has little relevance or meaning for a person, these elements are unlikely to activate relevant situated conceptualizations. If no meaningful goal exists for the person in the current situation, then the broad ensemble of situational cues is unlikely to activate relevant situated conceptualizations, which most likely *did* include meaningful goals previously. A recent meta-analysis illustrates that social priming effects are indeed stronger when relevant goals are being pursued [40,41]. Strong effects of

self-relevance in the social priming literature further illustrate this point [28,29].

Thus, the situated conceptualization framework suggests that the most informative way of studying pattern completion inferences — including social priming — is to study them as packages of situated inferences — delivered as multimodal simulations — during goal-directed activity in situations currently meaningful to the participant. Accounts of social priming have begun exploring related possibilities [28,42,43]. Clearly, however, much remains to be learned about how the situated conceptualization framework operates. Indeed, we currently understand little about the framework in any depth or with any certainty [7].

### Conflict of interest statement

Nothing declared.

### Acknowledgements

I am grateful to Fritz Strack and Norbert Schwarz for the opportunity to write this article. This article has benefitted from conversations with Esther Papies.

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