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Brief report

The role of autonomic arousal in feelings of familiarity

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ABSTRACT

Subjective feelings of familiarity associated with a stimulus tend to be strongest when specific information about the previous encounter with the stimulus is difficult to retrieve (e.g., the *butcher-on-the-bus* phenomenon; [Mandler, G. (1980). Recognizing: The judgment of previous occurrence. *Psychological Review, 87*, 252–271.]). When a stimulus has been encountered previously and the circumstances of the encounter cannot be recollected, additional cognitive resources may be directed toward recollection processes; this resource allocation is accompanied by autonomic arousal [Dawson, M. E., Filion, D. L., & Schell, A. M. (1989). Is elicitation of the autonomic orienting response associated with allocation of processing resources?. *Psychophysiology, 26*, 560–572]. One easily measurable index of autonomic arousal is the skin conductance response (SCR). In the present study, participants studied lists of words and then gave recognition ratings to briefly displayed and masked studied and nonstudied test words while their SCRs were monitored. Results revealed a relationship between recognition ratings and the temporal characteristics of the SCR, supporting the idea that feelings of familiarity are indeed "feelings" in that they stem from autonomic arousal associated with cognitive resource allocation.

1. Introduction

A central claim of dual-process theories of recognition memory is that recognition decisions can be based either on the recollection of a particular study episode or on a less-specific "feeling of familiarity" evoked by a test item (see Yonelinas, 2002, for a review). Whereas some theories claim that the sense of familiarity is produced by direct access to a detectable familiarity "signal" generated by activated representations in memory (e.g., Reder et al., 2000), other accounts of familiarity argue that the sense of familiarity "is not to be found residing in a memory representation" (Jacoby, Kelley, & Dywan, 1989, p. 394); instead, according to these accounts, familiarity has an inferential basis. A prior encounter with a stimulus is said to result in more fluent perceptual and/or conceptual processing of that stimulus (Jacoby & Dallas, 1981; Rajaram & Geraci, 2000); consequently, fluent processing is often unconsciously attributed to past experience and labeled as "familiarity". This type of account has gained support from numerous experiments demonstrating that manipulations that increase the processing fluency associated with nonstudied test items tend also to increase the proportion of false alarms (false "familiarity") to those items (e.g., Johnston, Dark, & Jacoby, 1985; Johnston, Hawley, & Elliott, 1991).

Despite a great deal of research and debate on the memory mechanisms that might lead to a feeling of familiarity, there has been little investigation of the subjective "feeling" of familiarity as an *affective* process. In their description of familiarity as an unconscious attribution, Jacoby et al. (1989) cited the two-factor theory of emotion proposed by Schachter and Singer (1962) in which non-specific physiological arousal can be attributed to different emotions depending on the context.

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According to Jacoby et al., however, the feeling of familiarity is mediated by processing fluency rather than physiological arousal. Thus, although Jacoby et al. suggested that the feeling of familiarity is "similar to an emotion" (p. 394), they stopped just short of the claim that the feeling of familiarity *is* a type of emotion, and as such, might also be mediated by a form of physiological arousal.

However, an interesting study by Goldinger and Hansen (2005) does appear to suggest that there may be a link between physiological arousal and feelings of familiarity. In Goldinger and Hansen's experiment, participants were seated in a chair equipped with two speakers attached to the underside, through which a low-amplitude, low-frequency tone (an "arousal signal") could be played; the low-frequency tone was perceived as a buzz or vibration in the chair. After participants studied a set of words, pictures, and faces, their recognition of these items was tested, and on 50% of the trials, the test item was accompanied by a buzz. Furthermore, for half of the participants, the buzz was "subliminal", meaning that 75% of an independent group of participants indicated no awareness of the buzz. The other half of the participants received a higher-amplitude, clearly perceptible buzz accompanying 50% of the test items.

Goldinger and Hansen's (2005) key finding was that participants experiencing the subliminal buzz showed an increase in both hits and false alarms to the test items paired with the buzz, whereas participants given the clearly perceptible buzz did not show this effect. The authors speculated that a subliminal buzz would produce a non-specific feeling of arousal, which could then be mistakenly attributed to familiarity of the associated stimulus, while arousal produced by a perceptible buzz would correctly be attributed to the buzz and not to stimulus familiarity. Thus, whereas typical inferential explanations of familiarity focus on processing fluency, Goldinger and Hansen's experiment raises the possibility that it may be a type of arousal, rather than fluency, that is interpreted as a feeling of familiarity.

In this article, we describe an account of familiarity-based discrimination that suggests that what humans label as a feeling of familiarity is exactly that—a *feeling*. In other words, we propose that the sense of familiarity evoked by a particular stimulus is mediated by autonomic arousal. This proposal has intuitive appeal; a typical example of familiarity involves a person scanning a crowd of strangers and a second or two later he or she is startled by the sense that one of the individuals just scanned has been encountered somewhere before. When the particular time and place of the prior encounter remains elusive, the person may re-orient to the face in question (a "double-take") and, during the search for the appropriate identifying information stored in memory, may experience discernable feelings of arousal. Autonomic arousal is often an indicator of cognitive resource allocation (Dawson et al., 1989; Filion, Dawson, Schell, & Hazlett, 1991); in the example described above, arousal may reflect the allocation of resources in support of memory processes (i.e., resources allocated toward trying to determine who the person is). The particular form of autonomic arousal associated with a feeling of familiarity may therefore be characterized as a type of orienting response.

An autonomic *orienting response* is a form of autonomic arousal that occurs in response to a discrete stimulus. The network responsible for generating the orienting response includes the hippocampus, the ventromedial prefrontal and orbitofrontal cortices, the anterior cingulate, and the hypothalamus (Williams et al., 2000). The orienting response is thought to reflect a call for additional processing resources (Öhman, 1979) or the allocation of cognitive resources to a particular stimulus or process (Dawson et al., 1989; Filion et al., 1991). In the case of recognition memory, a sufficient degree of match between the features of the stimulus and stored representations—or alternatively, a sufficient degree of processing fluency—may automatically initiate a call for additional cognitive resources in support of recollection processes. According to this account, the feeling of familiarity is not a direct result of activation of memory representations, nor is it an attribution based on processing fluency. Instead, the feeling of familiarity stems from one's awareness of the autonomic arousal associated with the allocation of resources toward recollection. This proposal explains why strong feelings of familiarity are *not* generally experienced when one encounters a known individual in a typical setting. In such cases, sufficient information about the individual in question is easily accessed without the need for additional resources—therefore, there is no discernable increase in autonomic arousal. However, when one encounters a known individual in an atypical setting (e.g., the classic *butcher-on-the-bus* phenomenon; Mandler, 1980), additional processing resources may be required to access specific identifying information, and the call for these resources is accompanied by autonomic arousal which is labeled as a feeling of familiarity.

One easily measurable index of autonomic arousal is the skin conductance response (SCR), a rapid increase in skin conductance occurring approximately 1–3 s after the appearance of a discrete stimulus. SCRs are widely thought to be influenced by stimulus novelty, familiarity, intensity, and significance (Critchley, 2002) and their frequency increases during attention-demanding tasks (Dawson, Schell, & Filion, 2000). While SCRs have been associated with different and sometimes opposing factors, (e.g., novelty and familiarity), the nature of the task is often used to disambiguate which factor is responsible for producing the SCR (Öhman, 1979). For example, in a perceptual identification task, SCRs might occur more frequently in response to novel items, as they are thought to demand more resources for successful identification than more familiar items. On the other hand, in a standard recognition-memory task, SCRs might occur more frequently in response to familiar items if additional resources are required to support specific recollection of the study episode.

We initially conducted pilot studies pairing a standard study–test recognition memory paradigm with electrodermal monitoring in an attempt to measure autonomic arousal associated with recognition memory ratings. Unfortunately, few SCRs were observed in response to either studied or nonstudied test words in these experiments; evidently this task was insufficiently arousing. However, we obtained more frequent SCRs using a variant of the *recognition-without-identification* paradigm (Cleary, 2004, 2006; Cleary & Greene, 2000, 2001, 2004, 2005; Cleary, Langley, & Seiler, 2004; Cleary & Specker, 2007; Cleary, Winfield, & Kostic, 2007; Langley, Cleary, Kostic, & Woods, 2008; Lloyd, Westerman, & Miller, 2007; Peynircioglu, 1990).