Consciousness and Cognition 17 (2008) 1209–1218

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Intentional control based on familiarity in artificial grammar learning

Lulu Wan [a,b], Zoltán Dienes [c], Xiaolan Fu [a,*]

[a] State Key Laboratory of Brain and Cognitive Science, Institute of Psychology, Chinese Academy of Sciences, 4A Datun Road, Chaoyang District, Beijing 100101, China
[b] Graduate School of the Chinese Academy of Sciences, Beijing 100049, China
[c] Department of Psychology, University of Sussex, UK

ARTICLE INFO

Article history:
Received 8 March 2008
Available online 29 July 2008

Keywords:
Familiarity
Intentional control
Implicit learning
Artificial grammar learning
Unconscious

ABSTRACT

It is commonly held that implicit learning is based largely on familiarity. It is also commonly held that familiarity is not affected by intentions. It follows that people should not be able to use familiarity to distinguish strings from two different implicitly learned grammars. In two experiments, subjects were trained on two grammars and then asked to endorse strings from only one of the grammars. Subjects also rated how familiar each string felt and reported whether or not they used familiarity to make their grammaticality judgment. We found subjects could endorse the strings of just one grammar and ignore the strings from the other. Importantly, when subjects said they were using familiarity, the rated familiarity for test strings consistent with their chosen grammar was greater than that for strings from the other grammar. Familiarity, subjectively defined, is sensitive to intentions and can play a key role in strategic control.

1. Introduction

Much of the knowledge we acquire for dealing with the world appears to be implicit. We can learn to appreciate certain styles of music, obey cultural rules, or gain perceptual motor mastery of a domain without consciously knowing the underlying regularities. Reber (1967) initially introduced the artificial grammar learning paradigm as a way of investigating such implicit learning. Typically, in artificial grammar learning experiments, subjects are asked to memorize or look at letter strings for some minutes, and only then told that a complex set of rules underlay these training strings. In the following test stage, subjects are asked to classify each test string as grammatical or not. Generally, classification performance is above chance level (typically about 65%). Thus, people can learn the structure of an artificial grammar without trying to do so and in fact in such a way that the knowledge is difficult to express (e.g., Reber,1967, 1989; Berry & Dienes, 1993; Cleeremans, Destrebecqz, & Boyer, 1998; Pothos, 2007; Shanks, 2005).

It is a common experience to find a person or event unexpectedly familiar or unfamiliar for reasons we could not state. Further, familiarity can be acquired incidentally. Thus, it is natural to speculate that processes of familiarity play a role in implicit learning (e.g. Higham, 1997; Shanks, Wilkinson, & Channon, 2003; Whittlesea & Leboe, 2000; Tunney, 2007). Indeed, knowledge of specific strings or parts of strings (chunks) play a central role in artificial grammar learning (e.g., Dulany, Carlson, & Dewey, 1984; Lotz et al., 2006; Perruchet & Pacteau, 1990; Servan Schreiber & Anderson, 1990). In these cases people are sensitive to the presence of stimuli that are *objectively* familiar to them, i.e., as matter of fact they have come across those chunks before. For instance, the process of familiarity has been indicated by estimating the relationship between grammatical classification and fragment frequency (Knowlton & Squire, 1996; Meule-

* Corresponding author. Fax: +86 10 6487 2070.
E-mail address: fuxl@psych.ac.cn (X. Fu).

1053-8100/$ - see front matter © 2008 Elsevier Inc. All rights reserved.
doi:10.1016/j.concog.2008.06.007

mans & Van der Linden, 1997; Servan Schreiber & Anderson, 1990). In contrast to *objective familiarity*, Scott and Dienes (in press) explored the role of *subjective familiarity* in artificial grammar learning, that is, familiarity as a feeling (the feeling that something is objectively old). In the test phase, subjects were required to give a subjective rating of familiarity for each test string. Such subjective familiarity correlated both with the tendency to call an item 'grammatical' and also with objective properties of the test string, such as the frequency with which its chunks occurred in the training strings. In addition, Scott and Dienes asked subjects to indicate the basis of their grammaticality classification for each string (Dienes & Scott, 2005), with five options: guessing/random responding, intuition, familiarity, rules or memory. The most common choice was familiarity. That is, subjects often believed that their grammaticality classifications were indeed based on the relative familiarity of the strings.

Familiarity can be defined not just as an objective relation (of having been previously in mutual contact) or as a feeling, but also in terms of control. Specifically, Jacoby (1991) defined familiarity as that memorial process not affected by intentional control. Familiar items tend to be chosen regardless of one's intentions. Consider a subject asked to look at strings from two different grammars, grammars on which the subject has been trained to an equal extent. If the subject is shown test strings from both grammars familiarity would not, on Jacoby's definition, allow the person to choose strings from just one or other of the grammars. Dienes, Altmann, Kwan, and Goode (1995), however, confirmed that people trained on two grammars in turn could substantially control which grammar they used. When people were asked to respond to just one grammar and treat the other grammar as ungrammatical, they could do so. However, Dienes et al. did not determine on which knowledge sources it appeared to subjects they based their decisions. Maybe subjects used recollection or rules to discriminate the grammars. The results of Dienes et al. raise the question of whether subjective familiarity could be manipulated by intentions.

In the current study, we conducted two experiments to explore whether subjective familiarity could be controlled intentionally when subjects are trained on two artificial grammars. In both experiments, we replicated the Dienes et al. (1995) finding that incidentally acquired knowledge of two artificial grammars could be applied strategically and explored whether such control could be exerted when people felt they were using familiarity. We asked subjects to rate the familiarity of each string and also state the basis on which they made their grammaticality decision: guessing, intuition, familiarity, rules or memory (see Dienes, 2008, for evidence that such attributions pick out qualitatively different types of knowledge). In Experiment 1 both grammars were trained equally so should induce equal feelings of familiarity. In Experiment 2, the to-be-ignored grammar was trained for twice as long as the target grammar, to determine if intentional control could over-ride even strong training biases in determining subjective familiarity.

2. Experiment 1

2.1. Methods

2.1.1. Design

We used a 2×2 between-subjects design: grammar (first vs. second) $\times$ test order (classification first vs. familiarity rating first). In the study stage, all the subjects were trained first on one grammar (grammar 'A') and then the second grammar (grammar 'B'). In the test stage, half of the subjects were asked to check strings from the first grammar; the other half were asked to check strings from the second grammar. In addition, half of the subjects classified and gave source attributions and then rated familiarity; the other half rated familiarity, and then classified and gave source attributions.

2.1.2. Subjects

Forty undergraduate students (23 male, 17 female) from several universities in Beijing took part in the experiment. None of them had participated in any implicit learning experiment previously. They were randomly assigned to the four cells of the design.

2.1.3. Materials

Two grammars, the first grammar (A, see Fig. 1) and the second grammar (B, see Fig. 2), were taken from Dienes et al. (1995) and Reber (1969). Each grammar produced 52 strings between five and nine letters in length, of which 32 were displayed in the study stage and the remaining 20 in test stage. Ten ungrammatical strings were generated from each grammar by having a legal beginning bigram and final letter, but a leap between nodes at two points in the finite state grammar. The test set consisted of 20 ungrammatical strings and 20 grammatical strings from each grammar. The 60 test strings were assigned to 60 triplets. Each triplet included one string obeying the first grammar, one obeying the second grammar and one ungrammatical string. Each string was displayed in three different triplets, but no two strings occurred together more than once. Order of presentation within a triplet was randomized. The same triplets were shown to all subjects, but the sequence of triplets was randomized separately for each subject.

An E-prime 1.2 program (Schneider, Eschman, & Zuccolotto, 2002) was used to control the exposure of instructions, stimuli and the recording of responses.