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Intentional control based on familiarity in artificial grammar learning

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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-

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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.

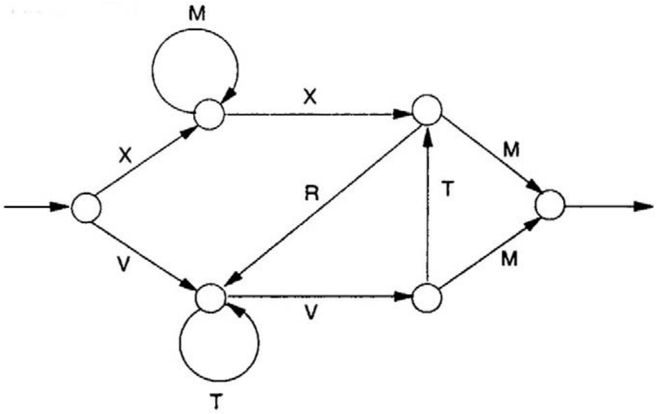

Fig. 1. Grammar A.

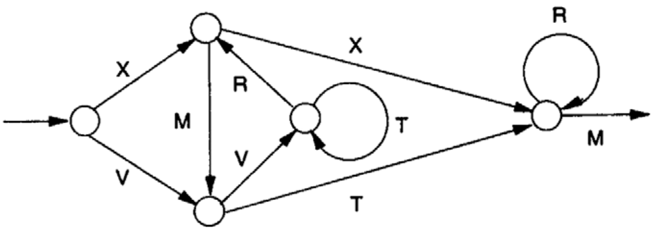

Fig. 2. Grammar B.

2.1.4. Procedure

In the study stage, the training strings generated from grammar A were displayed one at a time at the center of the screen. Subjects were asked to type each string and memorize it, pressing "enter" for the next sting. The set of grammar A training strings were repeated three times in a different random order. After a 30 s break, grammar B was displayed in the same way. After training, subjects were told that the orders of letters in each string before and after the short break were generated from different sets of complex rules. Half of subjects were asked to check strings from the first grammar; the remaining subjects were asked to check strings from the second.

In the test stage, half of the subjects were given three tasks in this order:

(1) classification, subjects chose one string from the triplet that matched their target grammar (first or second grammar);
(2) attribution, subjects chose which knowledge source they based their classification on. The attribution categories were: guessing, intuition, familiarity, rules and memory. Guessing was defined as indicating that subjects felt their judgment had no basis whatsoever, they may as well flipped a coin; intuition as they had some confidence in their judgment but they had no idea why it was right; familiarity as they chose the string that seemed most familiar; rules as they chose according to a rule or rules obtained in the training stage that they could state if asked; and, memory as the judgment was based on a recollection of one or more of the training strings;
(3) familiarity rating, subjects rated the degree of familiarity of each triplet on a scale (0–100) where 0 was defined as completely unfamiliar and 100 as completely familiar.

For the other half of subjects, familiarity was rated first, then classification and attribution categories given. Each test string was displayed in white on a gray screen.

2.2. Results

There were no significant effects involving whether subjects were asked to endorse the first or second grammar or whether classification preceded familiarity ratings or vice versa, so analyses were collapsed over these variables.

2.2.1. Overall control

Table 1 shows the proportion of times items were endorsed that belonged to the grammar consistent with the subject's intentions, belonged to the inconsistent grammar, or to neither grammar. Consistent with Dienes et al. (1995), strategic

Table 1
Overall means with standard deviations in parentheses in Experiments 1 and 2

	Consistent	Inconsistent	Ungrammatical	Strategic knowledge	Obligatory knowledge
Experiment 1	0.555 (0.203)	0.237 (0.157)	0.208 (0.121)	0.318 (0.342)	0.502 (0.220)
Experiment 2	0.486 (0.174)	0.291 (0.152)	0.223 (0.100)	0.195 (0.311)	0.533 (0.205)

knowledge is the difference in proportions endorsed between the consistent and inconsistent grammars, and obligatory knowledge is the proportion of inconsistent grammatical strings endorsed out of all inconsistent and ungrammatical strings. If the subjects had strategic control over the use of their knowledge, strategic knowledge should be above zero. If there was obligatory application of the inconsistent grammar, obligatory knowledge should be above 0.5.

The overall level of strategic knowledge was significantly above baseline (zero), $t(39) = 5.884$, $p < .001$. The overall level of obligatory knowledge was not above baseline (0.5), $t(39) = .048$ (95% confidence interval for difference from baseline −0.069:0.072). That is, subjects had intentional control over the application of their knowledge; further, there was no evidence overall for a to-be-ignored grammar applying against one's intentions. Both results replicate Dienes et al. (1995). This raises the question: can such control be based on familiarity?

2.2.2. Knowledge attributions and control

Fig. 3 shows the proportion of different knowledge attribution types subjects gave in Experiments 1 and 2. Importantly, subjects were especially inclined to use the familiarity attribution (cf. Scott & Dienes, in press). The proportion of familiarity responses was significantly higher than the proportion of any the other categories, *ps* < .05, with paired *t*-tests corrected to control familywise error at the .05 level (Hochberg's, 1988 sequential Bonferroni).

But was strategic control exerted when people believed they were using familiarity? Table 2 shows the amount of strategic and obligatory knowledge for each attribution category in Experiments 1 and 2, respectively. As can be seen, subjects

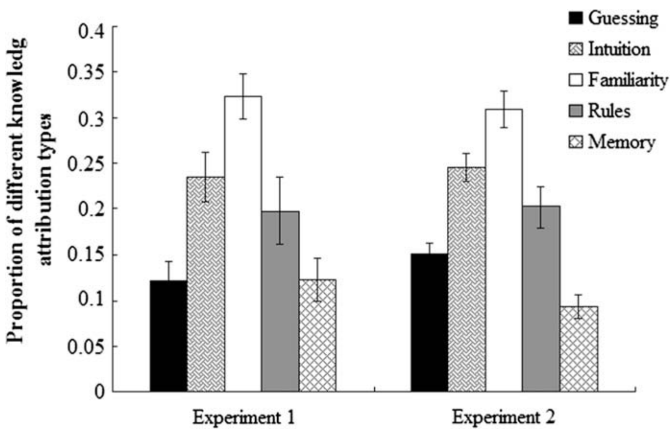

Fig. 3. Proportion of different knowledge attribution types. Bars indicate plus and minus one standard error in Experiments 1 and 2.

Table 2
Strategic knowledge and obligatory knowledge by attribution in Experiments 1 and 2

	Experiment 1		Experiment 2	
	M	*SD*	*M*	*SD*
Strategic knowledge				
Guessing	0.234	0.463	0.140	0.393
Intuition	0.186	0.488	0.095	0.423
Familiarity	0.288	0.401	0.183	0.381
Rules	0.533	0.422	0.300	0.547
Memory	0.390	0.558	0.177	0.675
Obligatory knowledge				
Guessing	0.456	0.298	0.471	0.295
Intuition	0.532	0.321	0.550	0.281
Familiarity	0.538	0.281	0.529	0.261
Rules	0.359	0.316	0.481	0.336
Memory	0.624	0.421	0.720	0.359

mainly had no detectable obligatory knowledge, expect for the rules attribution category, $t(25) = -2.284$, $p < .05$, which was below baseline (this surprising effect was not replicated in the next experiment and disappears with sequential Bonferroni correction). Importantly, subjects had significant strategic control not only when they thought they were using conscious rules or memory, but also when they attributed their answers to each of familiarity, intuition, or random guessing (all effects significant $ps < .05$ with Hochberg's sequential Bonferroni correction). When people say they are using familiarity, they can control which of two grammars is giving rise to that familiarity.

2.2.3. Familiarity rating and control

Fig. 4 shows the proportion of times that subjects chose the string with the highest, medium or lowest familiarity rating in each triplet, when subjects said they were basing their decision on familiarity. Subjects overwhelmingly choose the string with the highest familiarity rating rather than those with medium or lowest familiarity ratings (significant with sequential Bonferroni): highest compared to medium familiarity, $t(39) = 7.216$, and highest compared to lowest, $t(39) = 7.007$. There was no detectable difference in proportion of choices of medium to lowest rated strings, $t(39) = 1.179$, $p > .05$. In sum, subjects were sensitive to subjective familiarity in making grammaticality decisions.

2.3. Discussion

The aim of Experiment 1 was to investigate whether strategic control could be exerted when it seemed to subjects they were basing classifications on familiarity. Subjects overall had substantial strategic knowledge with no detectable obligatory knowledge. That is, people could after learning two artificial grammars pick out strings of one grammar from the other. In addition, among all the five attribution categories indicating the source of the judgment (guessing, intuition, familiarity, rules and memory), subjects believed they used familiarity more than any other source. Importantly, when subjects said they were using familiarity, they had strategic control. When subjects said they were using familiarity, there was no detectable tendency for the to-be-ignored grammar to be endorsed more than ungrammatical strings (though the upper limit of the 95% confidence interval was 63%—where baseline is 50%). By contrast, according to Jacoby's, 1991 approach, familiarity is applied automatically, so if subjects are equally familiar with two grammars, they should not be able to discriminate them using familiarity, but would endorse strings from either of those grammars rather than a non-grammatical string. Interestingly, there was substantial strategic knowledge for all the attributed bases of subjects' classifications. That is, strategic control could be implemented not only when subjects were aware of knowledge relevant for discriminating the grammars (rules and memory), consistent with Jacoby's approach, but also when they did not consider themselves as having conscious knowledge of structural differences between the grammars (guessing, intuition and familiarity). That is, control of one's knowledge is consistent with not being aware of the structural knowledge allowing control (believing control to be based on guessing, intuition or familiarity), or indeed not being aware of having structural knowledge at all (believing control to be based on guessing; cf. Dienes et al., 1995).

Dienes et al. (1995) found that people had substantial strategic control over their knowledge even when the inconsistent grammar was trained twice as long as the consistent grammar. However, again, Dienes et al. did not consider the role of familiarity. What is the role of people's subjective feeling of familiarity when the to-be-ignored grammar has been trained more than the consistent grammar? In Experiment 2, the main aim was to examine whether subjective familiarity could guide strategic choice of a less-well trained grammar.

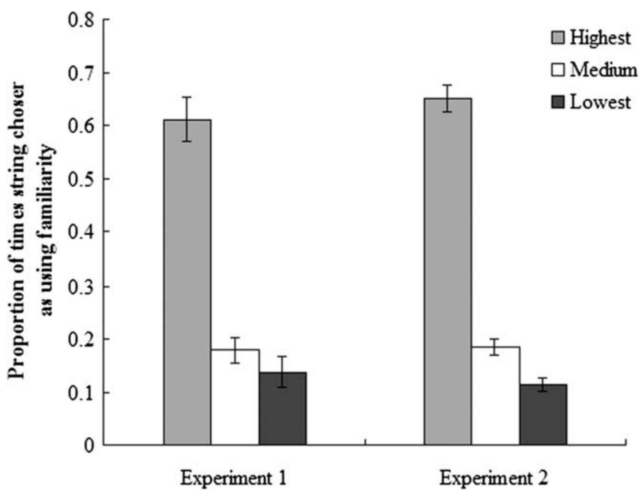

Fig. 4. Proportion of times string chosen with highest, medium or lowest familiarity rating when subjects said they were basing their decision on familiarity. Bars indicate plus and minus one standard error in Experiments 1 and 2.

Experiment 2 also addresses a methodological point. When subjects made their attribution choices in Experiment 1, the familiarity attribution type was always displayed in the middle position. The five attribution types were always ordered from top to bottom of the screen: guessing, intuition, familiarity, rules and memory. Subjects may have used an intermediate response as a default. In Experiment 2, familiarity was placed in three different positions.[1]

3. Experiment 2

3.1. Methods

3.1.1. Design

The design was the same as Experiment 1, with the following exceptions. We counterbalanced exposure order of grammar A and B in the study stage, and all subjects except for control groups rated familiarity last, after classifying and giving source attributions to the string. There were no detectable effects in Experiment 1 of whether familiarity was rated first or last. Also, display order of the attribution types was varied in the test stage. Furthermore, two control groups were included: in the trained control group, after the study phase subjects just rated the familiarity of each triplet from a scale of 0–100; in the untrained control group, subjects were only asked to rating the familiarity of each triplet in the test phase.

3.1.2. Subjects

One hundred and eighty undergraduate students (87 male, 93 female) from several universities in Beijing, mainly Beijing Forestry University and University of Beijing of Science and Technology Beijing, took part in Experiment 2. None of them had participated in any implicit learning experiment previously. The untrained control group contained 20 subjects, and each of the experimental groups and the trained control group contained 40 subjects.

3.1.3. Materials

The same training and test strings were employed as Experiment 1.

3.1.4. Procedure

The procedure was identical with Experiment 1, with two exceptions. If subjects were asked to check the first grammar, then subjects received two blocks of these strings and four of the second grammar; and vice versa if subjects were asked to check strings generated from second grammar. In the test stage, all the subjects classified, gave source attributions and rated familiarity in that order. Three levels of attribution orders were included which were displayed from top to bottom of the screen as follows:

(1) guessing, intuition, familiarity rules and memory (same as Experiment 1);
(2) familiarity, intuition, guessing, rules and memory;
(3) guessing, familiarity, intuition, rules and memory.

In addition, the trained control group received the same study stage as above but subjects only rated familiarity in the test phase; the untrained control group also only rated familiarity of each triplet in the test phase.

3.2. Results

There were no significant effects involving whether grammar A was as the first or second grammar, nor of whether subjects were asked to endorse the first or second grammar.

3.2.1. Familiarity rating of control groups

The untrained group's mean familiarity was 51.30 ($SD = 16.124$) for grammar A items, 52.59 ($SD = 16.248$) for grammar B, and 50.49 ($SD = 15.207$) for ungrammatical items. For the trained control group, a paired t-test indicated that subjects rated strings from the grammar trained for a long time as more familiar than the strings from the grammar trained only a short time (58.71 vs. 53.63), $t(39) = 1.883$, and the latter were rated as more familiar than the ungrammatical strings (45.17), $t(39) = 4.795$, all $ps < .05$ (one-tailed). These results indicate that familiarity ratings behave exactly as they should—i.e. increasing with training exposure—if they were indeed measures of subjective familiarity (see also Scott & Dienes, in press, for further evidence).

3.2.2. Attribution orders and control

Fig. 5 shows the proportions of the different knowledge attribution types for three different attribution orders. A one-way ANOVA with order as the independent variable on each attribution separately, revealed that attribution order did not signif-

[1] We thank Luis Jiménez for suggesting this idea.

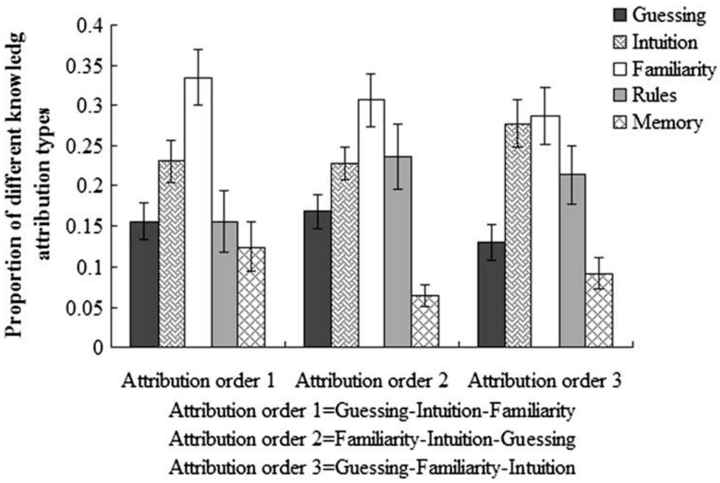

Fig. 5. Proportions of the different knowledge attribution types for three different attribution orders. Bars indicate plus and minus one standard error.

icantly affect the proportion of any attribution type, all *ps* > .05. Thus, subjects likely *said* they had used familiarity when they had. Subsequent analyses were collapsed over attribution order.

3.2.3. Overall control

The overall level of strategic knowledge (see Table 1) was significantly above baseline, $t(119) = 6.877$, $p < .0005$. The overall level of obligatory knowledge was not above chance, $t(119) = 1.766$ (95% confidence interval for difference from baseline −0.004:0.070). That is, subjects had intentional control over the application of their knowledge; further, there was no evidence overall for a to-be-ignored grammar applying against one's intentions, replicating Experiment 1. This raises the question: can such control be based on familiarity, even when the two grammars differed in amount of training?

3.2.4. Knowledge attributions and control

The pattern was identical with Experiment 1 (see Fig. 3): subjects were especially inclined to use the familiarity attribution (familiarity significantly higher than all other categories, *ps* < .05 with sequential Bonferroni).

But was strategic control exerted when people believed they were using familiarity? As can be seen in Table 2, subjects had no obligatory knowledge, expect for the memory attribution category, $t(70) = 5.160$, $p < .0005$. Significant strategic control occurred for all attributions, including when they attributed their answers to familiarity, $t(116) = 5.194$, all *ps* < .05 with sequential Bonferroni correction for all five categories. Importantly, when people said they were using familiarity, they could control which of two grammars would guide their choices.

3.2.5. Familiarity rating and control

The pattern was identical to Experiment 1, subjects overwhelmingly choose the string with highest rather than with medium or lowest familiarity rating regardless of which type of strings they chose. Comparing the proportion of times with highest to medium familiarity rating, $t(116) = 12.158$, and highest to lowest, $t(116) = 15.200$. Subjects also slightly preferred choosing strings with the medium rather than lowest familiarity ratings, $t(116) = 3.921$, (all *ps* < .0005 with sequential Bonferroni). That is, even when subjects were trained twice as long on the to-be-ignored grammar, they still went for most familiar string when they said they were using familiarity. Subjective familiarity can guide subjects' decision even for a less-well trained grammar.

3.2.6. Is familiarity inhibited or facilitated by intentions?

The trained control group allows a test of whether intentions enhance the familiarity of the target consistent grammar and/or inhibit the familiarity of the to-be-ignored inconsistent grammar. The trained control group had no intentions to use one grammar rather than another so provides a convenient baseline to compare the experimental subjects against, who did have such intentions. The proportion of times the consistent string had greater familiarity than the non-grammatical string for the experimental subjects was .581 ($SD = .125$), not significantly different from the proportion of times the string trained for a short time had a greater familiarity than the non-grammatical string for the untrained controls, .585 ($SD = .139$), $t(158) = .166$. Thus, there is no evidence for facilitation (the 95% confidence interval allows facilitation in the range −.050:.043). The proportion of times the inconsistent string had greater familiarity than the non-grammatical string for the experimental subjects was .605 ($SD = .116$), was significantly less than the proportion of times the string trained for a long time had a greater familiarity than the non-grammatical string for the untrained controls, .646 ($SD = .145$), $t(158) = 1.836$, $p < .05$ (one-tailed). Thus, there is evidence for inhibition (cf. Anderson & Green, 2001; Zhou, Wan, & Fu, 2007).

Table 3
Overall mean proportions of times each type of string had the highest familiarity rating with standard deviations in parentheses

	Consistent	Inconsistent
Experiment 1	0.443 (0.212)	0.340 (0.196)
Experiment 2	0.399 (0.172)	0.340 (0.200)
Total	0.410 (0.183)	0.340 (0.198)

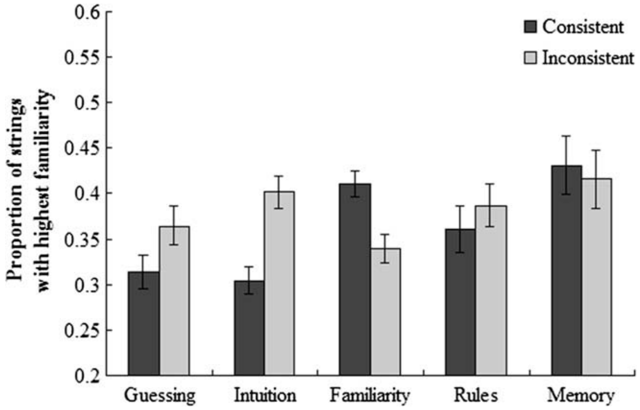

Fig. 6. Proportion of strings with highest familiarity rating for consistent and inconsistent strings for each attribution. Bars indicate plus and minus one standard error. Collapsed over Experiments 1 and 2. Differences between consistent and inconsistent strings are significant for responses attributed to familiarity and to intuition.

3.3. Discussion

The aim of Experiment 2 was to investigate the role of subjective familiarity in strategic control when the to-be-ignored strings should have more familiarity due to training. In terms of overall control, although subjects were trained twice as long on the inconsistent grammar as on the consistent grammar, subjects had substantial strategic knowledge. Moreover, subjects most commonly believed they based their decision on familiarity even when the objective familiarity of the consistent grammar was in fact lower than the inconsistent grammar. Importantly, when subjects believed they were using familiarity they exerted strategic control.

The results from both experiments raise the question as to whether the actual rated familiarity of strings consistent with the intended grammar is higher than strings from the inconsistent grammar? Can intentions change the source of subjective feelings of familiarity? We address this question more directly than the previous analyses by determining for each trial for each subject whether the consistent or inconsistent string in the triplet had the higher familiarity. To make it a stronger test we only considered those trials in which subjects said they were using familiarity.

Table 3 shows the proportion of times the consistent and inconsistent strings had the highest familiarity rating for each experiment for when subjects said they were using familiarity (and Fig. 6 shows the pattern for each attribution). A 2×2 (experiment [Experiment 1 vs. Experiment 2] $\times$ string type [consistent vs. inconsistent]) mixed-model ANOVA on proportion of times the string had the highest familiarity when subjects said they were using familiarity indicated a significant main effect of string type but no main effect nor interaction, $F(1,155) = 6.238$, $p < .05$, $\mu_p^2 = .039$. The consistent strings had the higher familiarity a greater proportion of the time (despite the fact that which grammar was consistent, A or B, was counterbalanced across subjects, as was whether the consistent grammar was first or second). That is, the amount of rated familiarity was sensitive to intentions.

4. General discussion

In the current study, we reported the results of two experiments showing subjects could intentionally control which grammar to apply while considering their responses to be based on familiarity. When subjects believed they were using familiarity, the rated familiarity of the consistent grammar was higher than that for the inconsistent grammar, even when the inconsistent grammar had been trained for twice as long. Intentions could over-ride a substantial amount of training in determining subjective feelings of familiarity.

Experiment 2 provided evidence that familiarity ratings have validity: For subjects whose only task in the test phase was to rate familiarity, the longer people were exposed to their grammar for, the higher the rated familiarity of the strings. Scott and Dienes (in press) also presented evidence for the validity of familiarity ratings. Consistently over four experiments objective measures of similarity (including fragment frequency and repetition structure) predicted ratings of familiarity (explaining about 20% of the variance). Further, Scott and Dienes (submitted for publication) showed that natural and manipulated fluency influences familiarity ratings. The familiarity ratings pass exactly the tests one would want them to pass to demonstrate that they track what subjects say they track—feelings of familiarity. Given this, the attribution category "familiarity" also gains credence from the fact that when subjects use that attribution, their responses were indeed predicted by familiarity ratings. Further, when people say they were using familiarity (in contrast to say the intuition or guessing categories) familiarity ratings were influenced by intentions so that the use of familiarity would enable strategic control. Indeed, when subjects said they were using intuition, consistent items had the highest familiarity a *lower* proportion of the time than inconsistent items, $F(1,153) = 5.869$, $p = .017$, $\mu_p^2 = .037$, and there was no difference for guessing, $F(1,137) = .501$, $p = .480$, $\mu_p^2 = .004$, see Fig. 6. Interestingly, subjective familiarity was apparently not the only means by which unconscious structural knowledge could be used for strategic control (cf. Dienes, 2008).

Consistent with the conventional view of familiarity as a single uni-dimensional feeling we suggest intentions can influence the determinants of such a feeling; another possible view consistent with our findings is that familiarity can come in different types (e.g. associated with the different grammars) and subjects could experience e.g. Type A and Type B familiarity simultaneously, allowing intentions to exert control via familiarity feelings. Either way, our finding is at odds with a dominant approach to defining familiarity, namely as that uni-dimensional memorial process which is insensitive to intentions (Jacoby, 1991). Our results show that this latter definition of familiarity dissociates from familiarity as a feeling indicating oldness. While we have nothing but admiration for Jacoby's work, we suggest it may be more fruitful to treat the sensitivity of familiarity to intentions as an empirical question rather than a definition.

Although we found almost perfect ability of subjects to control which grammar to apply, Higham, Vokey, and Pritchard (2000) using two different artificial grammars found substantial endorsements of a to-be-ignored grammar compared to non-grammatical strings (e.g. .51 proportion of inconsistent strings endorsed vs. .39 of non-grammatical strings in their Experiment 1), prima facie indicating obligatory application of knowledge, and hence familiarity in Jacoby's sense. Redington (2000) argued that Higham et al.'s results may follow from the grammars being especially similar to each other and the controlled application of knowledge of grammar A may thus sometimes lead to endorsements of strings from grammar B. Higham et al. (2000) argued that automaticity just was the presence of unintended consequences to one's knowledge, so the endorsing of strings from an inconsistent grammar because the strings were similar to those of the target grammar just is automatic knowledge. That is, consistent with Jacoby's approach, the failure to exclude strings is definitional of familiarity. The Jacoby or Higham and Vokey approach would classify knowledge as automatic, in other words based on a familiarity process, even if subjects stated on each trial that their response was based on conscious rules or recollection. The alternative approach taken here is to define familiarity either as an objective relation of having come in mutual contact (the fact of being old or familiar to the person), or as a mental state or feeling that this fact is true (subjective familiarity). On the Higham and Vokey approach, a mental state is one of familiarity or not depending on a specific state of affairs external to the subject, namely, on whether some strings are classified as grammar A or B according to an experimenter's grammars *which might have been different and thus could have classified otherwise*. This is an example of externalism in the philosophy of mind (see e.g. Wilken, Bayne, & Cleeremans, 2008). If the experimenter happened to classify all the new strings in the same way as the subject, there would be no familiarity. According to our approach, a state being one of subjective familiarity depends not on how the experimenter classifies strings, only on the mechanisms operating within the subjects' mind (namely, only on whether a mechanism was used that represents oldness, regardless of whether this mechanism makes the same choices as the experimenter).

Kinder and Assmann (2000) and Lotz and Kinder (2006) argued that familiarity played a key role in artificial grammar learning because ROC curves indicated the continuous use of information, consistent with a device producing a continuous feeling of familiarity. Our results support the claim that the continuous information used indeed often expresses itself as a degree of subjective familiarity. Note, however, that people are not always aware of the relevance of these feelings; we, like Scott and Dienes, found that people could classify even when they believed they were literally guessing or were responding randomly. This raises the question of whether familiarity itself can be an unconscious mental state (i.e. people are not aware that they know the oldness of a string), but this is a question we leave for future research.

Finally, we have not touched on the role of fluency in strategic knowledge. Kinder, Shanks, Cock, and Tunney (2003), following, for example, Jacoby, kelley, and Dywan, (1989), argued that familiarity in artificial grammar learning was based on fluency, i.e. the speed with which it takes to complete processing of a stimulus. Indeed, experimental manipulation of the clarification of a stimulus by Kinder et al. influenced subjects' grammaticality judgments. However, Scott and Dienes (submitted for publication) replicated these findings but argued that fluency accounts for a tiny proportion of the variance in subjective familiarity in artificial grammar learning. So what role fluency plays in strategic control of knowledge of artificial grammars remains an open question.

In sum, this paper argues that familiarity can be used for strategic control and is itself influenced by intentions. We hope that the role of intentions in controlling subjective familiarity will be explored in other implicit learning and memory paradigms (cf. Dienes & Fahey, 1998; Dienes & Longuet-Higgins, 2004; Fu, Fu, &Dienes, 2008; Higham & Vokey, 2004; Norman, Price, Duff, & Mentzoni, 2007).

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