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BRIEF REPORT

Adding the goal to learn strengthens learning in an unintentional learning task

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Abstract Previous research has demonstrated that contingency learning can take place in the absence of the intention to learn. For instance, in the color–word contingency learning task, each distracting word is presented most often in a given target color (e.g., "month" in red and "plate" in green), and less often in the other colors. Participants respond more quickly and accurately when the word is presented in the expected rather than an unexpected color, even though there is no reason why they would have the intention to learn the contingencies between the words and the colors. It remains to be determined, however, whether learning in such situations would benefit or suffer from adding the goal to learn contingencies. In the reported experiment, half of the participants were informed that each word was presented most often in a certain color, and they were instructed to try to learn these contingencies. The other half of the participants were not informed that contingencies would be present. The participants given the learning goal produced a larger response time contingency effect than did the control participants. In contrast to some results from other learning paradigms, these results suggest that intentional learning adds to, rather than interferes with, unintentional learning, and we propose an explanation for some of the conflicting results.

Keywords Implicit learning · Human memory · Automaticity · Goals

Within the literature on human contingency learning (Schmidt, 2012), several paradigms have emerged that have proved useful in the study of unintentional-learning processes. One example of this is the *color–word contingency learning paradigm* introduced by Schmidt and colleagues (Schmidt & Besner, 2008; Schmidt, Crump, Cheesman, & Besner, 2007; Schmidt & De Houwer, 2012, in press; Schmidt, De Houwer, & Besner, 2010). In this paradigm, each distracting word is presented most often in a certain target color (e.g., "month" most often in red, "plate" most often in green), and participants respond more quickly and accurately to trials in which the word is presented in its *high-contingency* color (e.g., "month" in red) rather than a *low-contingency* color (e.g., "month" in green). Contingency awareness is generally quite limited in this paradigm, and learning often seems to occur without awareness: Participants who say that they are not aware of the contingencies and who do not guess above chance which words went with which colors still show the effect (Schmidt et al., 2007). Because participants are typically unaware of the contingencies, it is unlikely that they have the intention to learn them. Moreover, the instructions remain silent about the presence of the contingencies, and participants are thus not asked to learn them. One could argue that participants might still form the intention to learn the contingencies in order to improve their performance in the response time task. However, the response time task is so simple (i.e., reacting to colors) and response times are so short that an intentional strategy to use contingency knowledge to improve performance is likely to backfire and actually hamper performance. Hence, the goal to learn does not appear to be *necessary* for color–word contingency learning.

One issue that has received relatively less attention is whether color–word contingency learning (and human contingency learning in general) is *moderated by* the goal to learn. In the present research, we investigated what impact explicit learning goals have on the amount of learning

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occurring in a paradigm that would otherwise result in unintentional learning—namely, the color–word contingency learning paradigm. We use the term "unintentional-learning paradigm" to refer to a learning task that, in the absence of the instruction to learn contingencies, would result in unintentional learning.

Intuitively, one would imagine that the goal to learn can only have a positive effect on the resultant learning. However, previous work assessing the impact of goals on learning in unintentional-learning paradigms has revealed null results, or even a counterintuitive *decrease* in the size of learning effects, from inducing a goal to learn. In artificial-grammar-learning work, Forkstam, Elwér, Ingvar, and Petersson (2008) compared learning between participants who were informed that there would be contingencies that made for an artificial grammar and participants who were not so informed. They found no effects of instruction on learning. Reber (1976), in contrast, actually observed *decreased* learning of the grammar when given the explicit goal to learn. These results suggest that the goal to learn interferes with unintentional learning.

Similar results have been reported in the evaluative conditioning literature. For instance, Fulcher and Hammerl (2001) paired some neutral haptic (touch) stimuli with positive haptic stimuli, and others with other neutral haptic stimuli. A standard evaluative conditioning effect was observed when the positively conditioned neutral stimuli were rated more positively than the neutrally conditioned neutral stimuli. However, this pattern was *reversed* in the participants who were told to learn the contingencies. Hence, in this case, the explicit goal to learn seems to have overridden the normal learning process, rather than strengthening it.

To assess the role of goals on contingency learning in the color–word contingency learning paradigm, half of the participants in our experiment were assigned to an instruction group and half to a control group. As is typical in most experiments on unintentional contingency learning, the control participants were not told about the contingencies at the start of the experiment. In contrast, the instructed participants were told that the color–word contingency relationships would be present in the task and that they should try to learn them. Subjective contingency awareness (i.e., verbal acknowledgment of noticing the contingencies) and objective contingency awareness (i.e., above-chance guessing of which word went with which color) were then assessed.

Method

Participants

A group of 46 Dutch-speaking undergraduates at Ghent University participated in the experiment in exchange for €4.

Apparatus

Stimulus and response timing were controlled by E-Prime software (Psychology Software Tools, 2002). Using an AZERTY keyboard, the participants pressed the "J" key for red, the "K" key for yellow, and the "L" key for green in both the main learning task and the objective awareness task. For the subjective awareness question, they pressed the "j" key for "ja" (yes) or the "n" key for "nee" (no).

Materials and design

The participants were seated approximately 60 cm from the screen. The stimuli were presented on a black background and consisted of three neutral five-letter Dutch words (*onder* ["under"], *maand* ["month"], and *plaat* ["plate"]) presented in three different print colors (red, yellow, and green). One word (e.g., *onder*) was presented most often (eight of ten times) in red, another word (e.g., *maand*) most often in yellow, and the third (e.g., *plaat*) most often in green. The words were presented equally often (one of ten times) in each of the two remaining colors. *High-contingency trials* were those in which the word was presented in its most frequent color. *Low-contingency trials* were those in which the word was presented in another color. The contingency effect was the difference in response times or accuracies between these two types of trials. The high-contingency color for each word was randomly determined for each participant, and the words were presented in bold, lowercase, 18-point Courier New font. The RGB values for the display colors were 255, 0, 0 (red), 255, 255, 0 (yellow), and 0, 255, 0 (green).

Procedure

First, participants were told that they would be responding to the print colors of the words. Only participants in the instructed group (N = 23) were then given the following (translated) additional instructions:

> Note: Each word in the experiment is presented most often in a certain color. Specifically, one word is presented most often in red, another word is presented most often in yellow, and a third word is presented most often in green. Try to learn which word is presented in which color as you perform the task.

Each trial began with a white fixation "+" for 150 ms, followed by a blank screen for another 150 ms, followed by a colored word for 2,000 ms or until a response was made. Following correct responses, the next trial started immediately. If the trial timed out or an incorrect response was made, "XXX" was presented in white for 500 ms, followed by the next trial. We presented 200 trials, selected at random with replacement. Afterward, contingency awareness was assessed. The participants were first asked whether they had noticed the color–word contingencies (subjective contingency awareness), with the question being essentially identical to the learning goal instruction. After this, participants were asked to guess which color each word had been presented in most often (objective awareness).

Results

The mean correct response latencies and percentage error data were analyzed (see Fig. 1). Trials on which participants failed to respond (less than 1 % of the data) were removed from the analyses. The correlations used for the awareness data were nonparametric Spearman's ρs, which provide better control for the influence of outliers with small sample sizes. The correlations using parametric Pearson's r were essentially identical.

Response latencies

An ANOVA for response latencies with the factors of Contingency (high vs. low) and Group (instructed vs. control) revealed a significant main effect of contingency, $F(1, 44) = 46.737$, $MSE = 1{,}506$, $p < .001$, $\eta_p^2 = .51$, indicating overall faster responses for high- than for low-contingency trials. The main effect of group was not significant, $F(1, 44) = 1.918$, $MSE = 11{,}569$, $p = .173$, $\eta_p^2 = .04$. Critically, the interaction between contingency and group was significant, $F(1, 44) = 4.419$, $MSE = 1{,}506$, $p = .041$, $\eta_p^2 = .09$, indicating a significantly larger contingency effect for the instructed group than for the controls. Planned comparisons revealed that the contingency effect was significant both for participants in the instructed group (high, 547 ms; low, 620 ms), $t(22) = 5.583$, $SE_{\text{diff}} = 13$, $p < .001$, $\eta_p^2 = .59$, and for participants in the control group (high, 533 ms; low, 572 ms), $t(22) = 3.950$, $SE_{\text{diff}} = 10$, $p < .001$, $\eta_p^2 = .38$.

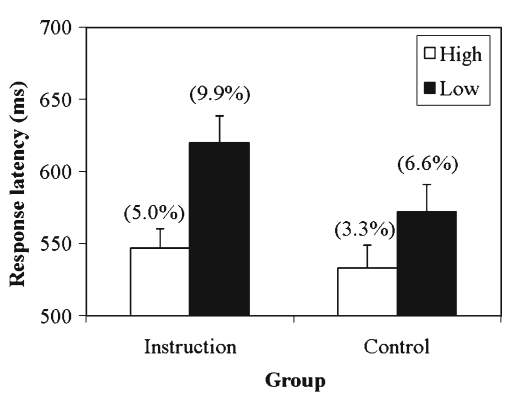

Fig. 1 Response latencies, standard errors, and error percentages as a function of contingency and instruction group

Percentage errors

An ANOVA for errors with the factors of Contingency (high vs. low) and Group (instructed vs. control) revealed a significant main effect of contingency, $F(1, 44) = 24.604$, $MSE = 16$, $p < .001$, $\eta_p^2 = .35$, indicating fewer errors overall on high- than on low-contingency trials. The main effect of group was also significant, $F(1, 44) = 5.177$, $MSE = 28$, $p = .028$, $\eta_p^2 = .10$, showing fewer errors in the control group than in the instructed group. Although numerically it was in the expected direction, the interaction between contingency and group was not significant, $F(1, 44) = .943$, $MSE = 16$, $p = .337$, $\eta_p^2 = .02$. Planned comparisons revealed that the contingency effect was significant both for participants in the instructed group (high, 5.0 %; low, 9.9 %), $t(22) = 3.999$, $SE_{\text{diff}} = 1.2$, $p < .001$, $\eta_p^2 = .42$, and for participants in the control group (high, 3.3 %; low, 6.6 %), $t(22) = 2.973$, $SE_{\text{diff}} = 1.1$, $p = .007$, $\eta_p^2 = .29$.

Contingency awareness

Overall, contingency awareness was high in this experiment, probably due to the very strong contingency manipulation (i.e., 80 % high-contingency trials). In the instructed group, 21 of 23 participants (91 %) said that they were aware of the color–word contingencies (subjective awareness). In the control group, 17 of 23 participants (74 %) said that they were aware. This four-participant (17 %) difference was suggestive but not statistically significant, $t(44) = 1.563$, $SE_{\text{diff}} = 11$, $p = .125$, $\eta_p^2 = .05$. Subjective awareness, however, did correlate significantly with the size of the error contingency effect, $\rho(44) = .349$, $p = .017$, and marginally with the response time contingency effect, $\rho(44) = .268$, $p = .072$. Objective awareness was 96 % in the instructed group and 88 % in the control group. This 8 % difference was again suggestive but not significant, $t(44) = 1.003$, $SE_{\text{diff}} = 7$, $p = .321$, $\eta_p^2 = .02$. These rates of objective awareness were well above chance (33 %) in both the instructed, $t(22) = 19.547$, $SE = 3$, $p < .001$, $\eta_p^2 = .95$, and the control, $t(22) = 8.468$, $SE = 7$, $p < .001$, $\eta_p^2 = .77$, conditions. Like the subjective-awareness measure, objective awareness was significantly related to the size of the error contingency effect, $\rho(44) = .311$, $p = .035$, and marginally related to the response time contingency effect, $\rho(44) = .259$, $p = .083$.

Discussion

In the reported study, we assessed the impact of explicit learning goals on the size of the color–word contingency-learning effect. Our results demonstrated a clear beneficial effect. Relative to participants in the control condition, participants given contingency learning instructions showed an 87 % significant increase in the size of the response time effect. Though it was not significant, there was also a 48 % numerical increase in the size of the error effect. Thus, our data show that the conscious intent to learn can have a beneficial effect on the resultant unintentional learning.

On the other hand, a small number of earlier studies concerning the effects of goals on artificial grammar learning (e.g., Reber, 1967) and evaluative conditioning (e.g., Fulcher & Hammerl, 2001) revealed a negative effect of the goal to learn on contingency learning. One interpretation of these negative effects is that the goal to learn activates explicit learning processes that counteract, and sometimes overrule, implicit-learning processes (e.g., Reber, 1989; see Lieberman, Chang, Chiao, Bookheimer, & Knowlton, 2004, for neurological evidence). Such an account, of course, has difficulty explaining the beneficial effects of goals in the present experiment.

One could posit, however, that the negative effects of the goal to learn in artificial-grammar-learning studies is related to the complexity of the information to be learned in those studies (i.e., the artificial grammar). This would imply that the goal to learn is beneficial when the to-be-learned information is simple (e.g., the simple contingencies in our study) but detrimental when the to-be-learned information is complex. If participants are left to rely on unintentional learning only, they might be more effective at picking up the more complex relationships, whereas the introduction of a learning goal causes participants to rely on simpler (but less correct) contingencies. This account in terms of difficulty does not, however, explain the negative effects of the goal to learn in evaluative conditioning studies. As in our study, evaluative conditioning studies typically involve only simple contingencies between two stimuli.

Another possibility is that the differences between studies result from the use of judgment versus performance tasks. Some have argued that judgment tasks (i.e., tasks in which learning is assessed on the basis of judgements; e.g., a standard evaluative-conditioning task) and performance tasks (i.e., tasks in which learning is inferred from response time performance; e.g., color–word contingency) are driven by inherently different types of learning (see Shanks & St. John, 1994, for a review). It may be the case that the harmful effects of intentional learning in evaluative conditioning and artificial grammar learning are due to the use of a classification judgment response (i.e., judgments of liking or grammaticality). For instance, in an evaluative taste-conditioning experiment, participants may normally learn which neutral taste goes with which valenced taste and subsequently rate neutral stimuli on the basis of the valenced stimuli with which they were paired. However, when given explicit learning instructions, participants may feel that their subsequent ratings of the neutral stimuli should not be based on the pairings and may overcompensate their valence ratings in the reverse direction. Thus, the learning of the relationships between stimuli may not actually be impaired. Indeed, contingency *awareness* is generally *increased* under such conditions (Baeyens, Eelen, & van den Bergh, 1990). Rather, participants might be merely changing how they decide to classify stimuli when given different instructions. Because participants can easily control their judgments, learning as assessed by judgments is very susceptible to these kinds of conscious strategies.

A similar argument could be made for the reduced learning effects of Reber (1967) with explicit learning instructions. Because participants in the instructed group were told to explicitly learn the grammar, they might be less inclined to base their judgments on intuition or gut feelings. Thus, *unintentional* learning (which might be more potent than intentional learning) would be undermined. As with the evaluative conditioning work, participants may not be *learning* contingencies to a lesser extent; their intuitions may still be shaped by the contingencies. Rather, they may simply be *expressing* that learning differently, with a change in their approach to categorization after being given learning instructions. In other words, their conscious strategy for making judgments might lead to the absence or reversal of the effect. In that sense, instructions in such paradigms reduce the observed learning effect, but not learning per se.

For this reason, a performance (i.e., response time) task such as the color–word contingency learning task would not produce the same detrimental effect of explicit learning instructions. As noted earlier, it is unlikely that participants *intentionally* use the contingencies to speed color identification performance, particularly given the speeded nature of the task. In fact, participants probably have little control over how learned information about contingencies influences their response time performance, thus making it unlikely that a conscious strategy to use or not to use contingency knowledge will counteract unintentional learning. More generally, the explicit instruction to learn contingencies might always strengthen *learning*, perhaps even in the tasks that have previously shown negative effects (e.g., the benefit is concealed by the costs associated with a categorization response). More work, of course, is warranted before making any strong conclusions on this matter. Whatever the actual cause of the discrepancy between our findings and previous findings, our study clearly shows that the goal to learn contingencies can facilitate learning, even in a paradigm that would otherwise result in unintentional learning.

Consistent with our findings, some other recent research has shown positive effects of goals on learning, though with goals of a different sort. In two unconscious-goal-pursuit experiments, Eitam, Hassin, and Schul (2008) demonstrated that implicitly primed performance goals (i.e., the goal to perform well in the task) had a facilitative effect on implicit-learning effects. Similarly, Corneille, Yzerbyt, Pleyers, and Mussweiler (2009) primed participants with the implicit goal to process similarities versus differences between stimuli, and they found that the goal to process similarities between stimuli led to larger evaluative-conditioning effects. Although performance goals such as these are clearly quite different from the goal to learn used in the present investigation, these past reports are consistent with our findings in showing that goals can have a positive influence on the amount of learning observed.

The question then arises as to what mechanism leads to an increase in learning with the introduction of a learning goal. One possibility is that goals lead to explicit knowledge about the contingency relations and that this explicit knowledge is used in combination with the unintentionally learned contingencies to produce a larger contingency effect. Indeed, while contingency learning in our paradigm often seems to occur without awareness (for related work, see Carlson & Flowers, 1996; Destrebecqz & Cleeremans, 2001; Jiménez & Méndez, 1999; Lewicki, Hill, & Czyzewska, 1992; Mayr, 1996; McKelvie, 1987; Nissen & Bullemer, 1987; Song, Howard, & Howard, 2007), the present results suggest that contingency awareness might help, as indicated by the positive correlations between awareness and learning effects. This contrasts with our previous work that had suggested that awareness does not help (Schmidt et al., 2007); this issue is something that we are currently investigating further.

Another possibility is that explicit goals lead to an increase in attention to the predictive dimension (i.e., the word in our paradigm), as a result of the fact that the predictive dimension is more relevant to the task. Indeed, work with various paradigms has demonstrated that attention to the predictive dimension is crucial for contingency learning to occur (e.g., Eitam, Schul, & Hassin, 2009; Jiang & Chun, 2001; Jiménez & Méndez, 1999). Thus, it could be the case that participants in the instructed group attend more to the word than do participants in the control condition, which could lead to stronger encoding of the current trial and/or to retrieval of previously encountered trials. Whatever the mechanism that mediates the impact of goals to learn on unintentional learning, our results show that the goal to learn can improve such learning. As such, it sheds new light on the relationship between goals and learning in general.

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References

Baeyens, F., Eelen, P., & van den Bergh, O. (1990). Contingency awareness in evaluative conditioning: A case for unaware affective–evaluative learning. *Cognition & Emotion, 4,* 3–18. doi:10.1080/02699939008406760

Carlson, K. A., & Flowers, J. H. (1996). Intentional versus unintentional use of contingencies between perceptual events. *Perception & Psychophysics, 58,* 460–470. doi:10.3758/BF03206821

Corneille, O., Yzerbyt, V. Y., Pleyers, G., & Mussweiler, T. (2009). Beyond awareness and resources: Evaluative conditioning may be sensitive to processing goals. *Journal of Experimental Social Psychology, 45,* 279–282.

Destrebecqz, A., & Cleeremans, A. (2001). Can sequence learning be implicit? New evidence with the process dissociation procedure. *Psychonomic Bulletin & Review, 8,* 343–350. doi:10.3758/BF03196171

Eitam, B., Hassin, R. R., & Schul, Y. (2008). Nonconscious goal pursuit in novel environments: The case of implicit learning. *Psychological Science, 19,* 261–267. doi:10.1111/j.1467-9280.2008.02078.x

Eitam, B., Schul, Y., & Hassin, R. R. (2009). Goal relevance and artificial grammar learning. *Quarterly Journal of Experimental Psychology, 62,* 228–238. doi:10.1080/17470210802479113

Forkstam, C., Elwér, Å., Ingvar, M., & Petersson, K. (2008). Instruction effects in implicit artificial grammar learning: A preference for grammaticality. *Brain Research, 1221,* 80–92.

Fulcher, E. O., & Hammerl, M. (2001). When all is revealed: A dissociation between evaluative learning and contingency awareness. *Consciousness and Cognition, 10,* 534–549.

Jiang, Y.-H., & Chun, M. M. (2001). Selective attention modulates implicit learning. *Quarterly Journal of Experimental Psychology, 54A,* 1105–1124. doi:10.1080/02724980042000516

Jiménez, L., & Méndez, C. (1999). Which attention is needed for implicit sequence learning? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 236–259. doi:10.1037/0278-7393.25.1.236

Lewicki, P., Hill, T., & Czyzewska, M. (1992). Nonconscious acquisition of information. *American Psychologist, 47,* 796–801.

Lieberman, M. D., Chang, G. Y., Chiao, J., Bookheimer, S. Y., & Knowlton, B. J. (2004). An event-related fMRI study of artificial grammar learning in a balanced chunk strength design. *Journal of Cognitive Neuroscience, 16,* 427–438.

Mayr, U. (1996). Spatial attention and implicit sequence learning: Evidence for independent learning of spatial and nonspatial sequences. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22,* 350–364. doi:10.1037/0278-7393.22.2.350

McKelvie, S. J. (1987). Learning and awareness in the Hebb digits task. *The Journal of General Psychology, 114,* 75–88.

Nissen, M. J., & Bullemer, P. (1987). Attentional requirements of learning: Evidence from performance measures. *Cognitive Psychology, 19,* 1–32. doi:10.1016/0010-0285(87)90002-8

Psychology Software Tools, Inc. (2002). E-Prime [Software]. Retrieved from www.pst-net.com

Reber, A. S. (1967). Implicit learning of artificial grammars. *Journal of Verbal Learning and Verbal Behavior, 6,* 855–863. doi:10.1016/S0022-5371(67)80149-X

Reber, A. S. (1976). Implicit learning of synthetic languages: The role of instructional set. *Journal of Experimental Psychology: Human Learning and Memory, 2,* 88–94. doi:10.1037/0278-7393.2.1.88

Reber, A. S. (1989). Implicit learning and tacit knowledge. *Journal of Experimental Psychology. General, 118,* 219–235. doi:10.1037/0096-3445.118.3.219

Schmidt, J. R. (2012). Human contingency learning. In N. M. Seal (Ed.), *Encyclopedia of the sciences of learning* (pp. 1455–1456). New York, NY: Springer.

Schmidt, J. R., & Besner, D. (2008). The Stroop effect: Why proportion congruent has nothing to do with congruency and everything to do with contingency. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 34,* 514–523.

Schmidt, J. R., Crump, M. J. C., Cheesman, J., & Besner, D. (2007). Contingency learning without awareness: Evidence for implicit control. *Consciousness and Cognition, 16,* 421–435.

Schmidt, J. R., & De Houwer, J. (2012). Does temporal contiguity moderate contingency learning in a speeded performance task? *Quarterly Journal of Experimental Psychology, 65,* 408–425. doi:10.1080/17470218.2011.632486

Schmidt, J. R., & De Houwer, J. (in press). Contingency learning with evaluative stimuli: Testing the generality of contingency learning in a performance paradigm. *Experimental Psychology*. doi:10.1027/1618-3169/a000141

Schmidt, J. R., De Houwer, J., & Besner, D. (2010). Contingency learning and unlearning in the blink of an eye: A resource dependent process. *Consciousness and Cognition, 19,* 235–250. doi:10.1016/j.concog.2009.12.016

Shanks, D. R., & St. John, M. F. (1994). Characteristics of dissociable human learning systems. *The Behavioral and Brain Sciences, 17,* 367–395.

Song, S., Howard, J. H., Jr., & Howard, D. V. (2007). Implicit probabilistic sequence learning is independent of explicit awareness. *Learning and Memory, 14,* 167–176. doi:10.1101/lm.437407