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OBSERVATION

# Are Task Irrelevant Faces Unintentionally Processed? Implicit Learning as a Test Case

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Faces are one of the most important signals for reading people's mental states. In sync with their apparent "chronic" (cross-situational) relevance, faces have been argued to be processed independently of the task one is currently performing. Many of these demonstrations have involved "capture of attention" or increased interference by faces functioning as distractors. Here we ask whether multiple repetitions of task irrelevant faces leave a trace in the system. Specifically, we tested whether repeating structures instantiated by task irrelevant faces are unintentionally or implicitly learned. Our findings indicate that although faces are indeed unique in that they are the only stimulus found to lead to implicit learning of complex rules when irrelevant, such learning is small in magnitude. Although these results support the conjecture that task irrelevant faces are processed, the functional significance of this learning needs to be assessed.

*Keywords:* face processing, implicit learning, mental accessibility, selective attention, social adaptation, task relevance



The relevance of stimuli to the task at hand has a strong influence on whether they are processed. The centrality of current task relevance to information processing is already apparent in the writings of William James (1890) as in much of the early work on selective attention (for a review see Triesman, 1969). Recently, the use of relevance as an explanatory concept has resurged in various literatures (e.g., Eitam, Yeshurun, & Hassan, 2013).

## Processing of Faces Regardless of Relevance?

A category of stimuli that is seemingly exempt from the effects of task relevance are human faces (Adams, Gray, Garner, & Graf, 2010; Lavie, Ro, & Russell, 2003; Pessoa, 2005). For example, using electrophysiology, Neumann, Mohamed, and Schweinberger (2011) showed that task irrelevant faces are processed under both high and low perceptual load conditions. In another demonstration, Cashdollar and colleagues (2013) report that not only were irrelevant face distractors processed but that they also improved the performance of amnesic patients on a focal task (Cashdollar, Lavie, & Düzel, 2013).

Notwithstanding the above demonstrations, the question of whether information from a face is cognitively accessible regardless of its current task relevance (or whether faces automatically "grab attention") is far from resolved as counter demonstrations are abundant. For example, Vuilleumier and colleagues (2001) showed that people performed at chance level when judging the expression, gender, or identity of neutral faces that had appeared in an irrelevant location at the immediately preceding trial.

A more recent version of the obligatory processing of faces focuses on emotionally expressive faces, especially ones expressing negative emotions (e.g., Hodsoll, Viding, & Lavie, 2011; for a review, see Compton, 2003). But results of multiple studies have challenged this conjecture too. For example, Schettino and colleagues used the temporal order judgment task to show that neither angry nor fearful faces lead to a prior entry effect when compared to neutral faces and hence, presumably do not bias early attentional

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processes (Schettino, Loeys, & Pourtois, 2013). Others yet have shown that processing of faces expressing emotion, like other stimuli, depend on their task relevance (Barratt & Bundesen, 2012). In yet another recent counter example, Lien and colleagues have shown using electrophysiology that emotional (fearful) faces do not automatically capture (spatial) attention (Lien, Taylor, & Ruthruff, 2013). Note that although the review above suggests that null results are abundant, failures to detect the unique status of faces may reflect either a true lack of effect or lack of sufficient sensitivity of the experiments to detect a small-sized effect (see Dienes, 2008). Keeping this in mind, we took multiple steps to reach a decisive answer regarding this question (see below).

## Implicit Learning as a Platform to Study Unintentional Processing

Implicit learning (for reviews, see Cleeremans, Destrebecqz, & Boyer, 1998; Frensch, 1998; Frensch & Runger, 2003; Perruchet & Pacton, 2006; Reber, 1989) is a form of unintentional learning of complex relations between individual stimuli (Dienes, Scott, & Wan, 2011). As a rule, different tasks that tap implicit learning have also been repeatedly shown to be highly sensitive to the task relevance of the stimuli. For example, we (Eitam et al., 2013) presented participants with multiple strings of concentric circles. The colors of the inner and outer circles were determined using two different and complex systems of rules ("artificial grammars")—one system of rules for the outer circles and one for the inner circles. Before participants began this familiarization phase, instructions deemed either the inner or outer circles task-relevant (for a different demonstration, see Tanaka et al., 2008). When participants' knowledge of the regularities was surprisingly tested, they displayed knowledge only of the system of rules that underlay the colors of the relevant circles. For example, if the outer circle was deemed relevant, then participants displayed knowledge of the regularity determining the coloration of outer circles but no knowledge of the regularities in the coloration of the internal circles). This held even though the regularities cuing the (task) irrelevant regularities were cued (presumably) at the test phase by presenting only the colors mapped to the irrelevant location (cf. Jiang & Leung, 2005). This suggests that, at least in this instance of task irrelevant stimulation, it is not the case that regularities are encoded but are latent (i.e., not applied; cf. Jiang & Leung, 2005; because of inattention, Logan, 2002). Rather, the irrelevant information is not encoded or activated at all.

Others have shown that task relevance is crucial for implicit learning using other experimental paradigms, such as the serial reaction time task (Jimenez & Mendez, 1999; Van den Bos & Poletiek, 2010), and also for the occurrence of a related phenomenon called *statistical learning* (Turk-Browne et al., 2005).

Although the processes that underlie implicit learning are not yet understood, it is generally agreed that it is an unintended outcome of processing (e.g., Perruchet & Pacton, 2006). As such, it is an excellent vehicle for investigating the degree to which irrelevant faces are processed by testing for their unintended traces.

## Implicit Learning of Task Irrelevant Faces?

In the current study we test whether faces are processed regardless of their current task relevance. Our measure of processing is unintentional learning and hence we ask whether faces would be learned regardless of their being irrelevant to the current task.

If faces are learned even when they are task irrelevant, this would be both one of the first demonstrations of implicit learning of complex rules that are instantiated by task irrelevant stimuli, and it would also strengthen the position that faces are processed (encoded) regardless of their task relevance. Finally, it would also lend rare support to the existence of what we (Eitam & Higgins, 2010; Eitam & Higgins, in press) termed *chronic relevance*—stimuli that were learned to carry valuable information for the organism across multiple contexts and hence are always processed, at least to some degree (for similar positions, see Broeren & Lester, 2013; Nairne, & Pandeirada, 2008). If, on the other hand, faces are like other stimuli in not being implicitly learned when they are task irrelevant, even given a sufficiently sensitive test, this would be fresh evidence in support of the necessity of task relevance for implicit learning processes as well as for other unintentional processes such as priming (for a recent review, see Eitam & Higgins, 2010). This would also strengthen the position that "faces are not special" in the sense of being cross situationally (i.e., chronically) processed (e.g., Schettino, Loeys, & Pourtois, 2013).

Finally, our study also begins to consider whether and how implicit learning functions in the learning of social grammars (i.e., the complex relationships that govern our social environment).

A final note is in place. Task relevance can be studied at multiple levels of explanation (DeHouwer & Moors, in press; Marr, 1982). Elsewhere we have attempted to study it at the algorithmic (mechanism) and implementation levels (Eitam & Higgins, 2010; Eitam, Miele, & Higgins, 2013; Eitam & Higgins, in press). Given that the purpose of the current article is to test whether the phenomenon (task irrelevant learning of faces) exists at all, our current focus will be on the functional behavioral level. Specifically, we test whether faces are unique in that they are learned even when they are unnecessary for performance of a specified task.

## Experiment 1: Learning the Grammar of Irrelevant Faces but Not of Irrelevant Colors

### Method

**Participants.** Ninety-eight Columbia University students participated for either class credit or pay (60 women, $M_{age} = 21.80$, $SD = 5.09$).[1] They were randomly assigned to one of four conditions determined by the procedure described below.

**Materials and Procedure.** We used our modification of the classic artificial grammar learning paradigm (Eitam et al., 2009; Eitam et al., 2013b; Reber, 1967). Participants first underwent an exposure phase in which they were shown strings of faces encircled by colored ovals (see Figure 1), for 7 s each. Participants were instructed to memorize each sequence and were periodically asked if a newly presented string was the same as the one they last saw (Eitam et al., 2009). Each face varied across three dimensions (age, race, and emotional expression) to allow for maximal discrimination among the stimuli. Task relevance of the faces was manipu-

[1] Because of an experimenter error, the 12 first participants failed to complete the demographic questionnaire.

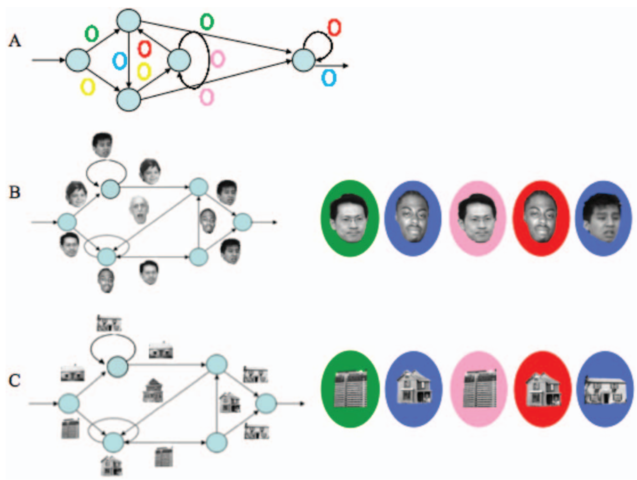


*Figure 1.* Figure is for demonstration purposes only; different face and building stimuli were used in the experiment. A: Grammar used to generate the surrounding color ovals in all three experiments. B: The grammar used to generate face strings in all experiments and an example training stimulus. C: The grammar used to generate building strings in Experiments 2 and 3 and an example training stimulus. Grammars were adapted from those used by Dienes, Altman, Kwan, & Goode, 1995. Stimulus images courtesy of Michael J. Tarr, Center for the Neural Basis of Cognition and Department of Psychology, Carnegie Mellon University, http://www.tarrlab.org/. The color version of this figure appears in the online article only.

lated by instructing half of the participants to memorize the faces (faces task relevant), and the other half of the participants to memorize the colors of the surrounding ovals (faces task irrelevant). Unbeknownst to the participants, all of the sequences in the training phase adhered to two different artificial grammars—one grammar for faces and another for the surrounding colored ovals (see Figure 1A). There were 32 training strings, each shown in a random order and appearing three times, for a total of 96 trials.

After the exposure ended, participants were informed that the sequences they had just seen had in fact followed a complex system of rules and, orthogonally to the stimulus that was relevant for them, were tested on either the grammar instantiated by faces or the one instantiated by colors. Participants who were tested on the grammar of faces were shown 40 new strings of faces, each without any surrounding color, half of which were grammatical and half of which violated the grammar. They were asked to determine whether each was grammatical or nongrammatical using their "gut feeling." Correspondingly, the participants tested on the color grammar were shown 40 new strings of color, each without any enclosed face. Twenty of these test sequences were grammatical, and 20 were not. In both conditions participants were not given any feedback about their answers to minimize within-test learning.

Hence half of the participants were tested on a grammar instantiated by stimuli that had been made task relevant for them (faces task relevant + face grammar test; color task relevant + color grammar test) and the other half were tested on a grammar instantiated by stimuli that had been made irrelevant for them (faces task relevant + color grammar test; color task relevant + faces grammar test).

## Results

To increase the integrity of the data, we applied the following filters to data from all three experiments: First, the data of participants who gave the same response in over 80% of the test trials were excluded from further analysis ($n = 2$ in Experiment 1). Next the data of participants whose grammar test scores were two standard deviations above or below their groups' mean were also excluded ($n = 4$ in Experiment 1).

**Comparing performance of all groups.** A 2 (Relevance: relevant, irrelevant) × 2 (Stimuli: faces, colors) analysis of variance (ANOVA) revealed only a significant main effect of relevance, $F(1, 88) = 10.76$, $p < .01$. Planned contrasts supported that the percent of correct classifications for relevant stimuli ($M = 57.71$, $SD = 11.86$) was significantly higher than for irrelevant stimuli ($M = 50.75$, $SD = 8.62$).

**Comparing each group's performance to chance.** Although the lack of an interaction effect suggests that faces and colors replicate the results of Eitam and colleagues (2009, 2013b) and suggest that relevance affects faces and nonface stimuli alike, one could argue that the relevant analysis is whether groups learned at all (rather than whether they reliable differed in their degree of learning). To test this (see also Eitam et al., 2009, 2013b), we used planned contrasts comparing each group's performance to chance or guessing level performance (which is 50% in the current setting). Replicating our previous results, when the grammar was instantiated by colors it was reliably learned when the colors were task relevant ($M_{\text{relevant colors}} = 56.88\%$, $SD_{\text{relevant colors}} = 12.43$), $t(23) = 2.71$ $p < .05$, 95% confidence interval $(\text{CI})_{\text{relevant colors}} = 51.63\%–62.12\%$. When the colors were task irrelevant, however, no learning was observed, $M_{\text{irrelevant colors}} = 48.51\%$, $SD_{\text{irrelevant colors}} = 10.49$, $t(20) < 1$, 95% $\text{CI}_{\text{irrelevant colors}} = 43.74\%.53.29\%$. In contrast, when the grammar was instantiated by faces, participants showed reliable learning not only when the faces were task relevant, $M_{\text{relevant}} = 58.59\%$, $SD_{\text{relevant faces}} = .11.45$, $t(22) = 3.60$, $p < .005$, 95% $\text{CI}_{\text{relevant faces}} = 53.63\%.63.54\%$, but also when they were task irrelevant $M_{\text{irrelevant colors}} = 52.71\%$, $SD_{\text{irrelevant colors}} = 6.16$ $t(23) = 2.15$ $p < .05$, 95% $\text{CI}_{\text{irrelevant colors}} = 50.11\%–55.31\%$.[2]

## Summary

Although Experiment 1 replicated the well-established effect of task relevance on implicit learning, it also uncovered weak implicit learning of the grammar instantiated by irrelevant stimuli—but only when these irrelevant stimuli were faces.

Although these results support the notion that there is obligatory processing for faces, there is another, more trivial, explanation for our results. Namely, perhaps faces—but not colors—enjoyed some processing benefit in Experiment 1 because the faces always appeared in the focus of the spotlight of attention whereas the

[2] A $t$ test on the difference in learning between the irrelevant conditions (corrected for unequal variances) was marginally reliable $t(31.43) = 1.61$, $p = .06$ (one-tailed).

colors always appeared in the periphery (Posner, Snyder, & Davidson, 1980; but see, Eitam et al., 2013b). To test which of these explanations is correct, we reran Experiment 1 with the addition of a critical new group where the grammars were instantiated by buildings, which, like faces, always appeared in the center.

Using buildings as a comparison condition has two other benefits. One is that previous experiments have suggested that faces, but not houses, are processed regardless of task relevance (e.g., Carmel, Fairnie, & Lavie, 2012). Another benefit from using buildings as a control group is that it enables us to test what can be called the *dedicated processing* alternative of chronic relevance or attentional capture. Specifically, it has been proposed that faces, because of their chronic relevance, are processed by a dedicated (Kanwisher, McDermott, & Chun, 1997) or expert system (Bukach, Gauthier, & Tarr, 2006). Importantly, buildings/places are also considered to be processed by a dedicated system (Aguirre, Zarahn, D'Esposito, 1998; Epstein & Kanwisher, 1998). Hence, if processing regardless of task relevance means "processed by a dedicated system," a grammar instantiated by buildings should also be learned regardless of current task relevance. Conversely, this alternative would not be supported if faces but not buildings were learned when they are task irrelevant.

## Experiment 2: A Test of Implicit Learning for Irrelevant Buildings Versus Irrelevant Faces

### Method

**Participants.** Ninety-two Columbia University students participated for either class credit or pay (63 women, *M*age = 21.33, *SD* = 4.52). They were randomly assigned to one of four conditions determined by the following procedure.

**Materials and Procedure.** The design of this experiment was identical to that of Experiment 1 but for one critical change. As our interest lay in comparing the implicit learning of relevant and irrelevant faces versus relevant and irrelevant buildings, the two conditions in which participants were tested on the grammar instantiated by colors were replaced with two additional conditions in which participants saw the same grammar instantiated by buildings. Each face and building varied across several dimensions to allow for maximal discrimination among the stimuli (faces—see Method in Experiment 1; buildings—number of stories high, type, location; see Figure 1B for buildings grammar and example buildings string).

Task relevance of the stimuli dimension (face, building, and colored ovals) was manipulated by instructing participants in one of the face conditions to memorize the faces, and participants in the second face condition to memorize the colors of the surrounding ovals. The same was done for participants in the buildings conditions. Once again, regardless of their task relevance, faces or buildings were always in the focus of spatial attention (i.e., they were in the center of the hypothetical spotlight). Thus, participants were randomly assigned to one of four conditions: face task relevant (color irrelevant), face task irrelevant (color relevant), building task relevant (color irrelevant), and building task irrelevant (color relevant). Then, participants were exposed to strings that obeyed two grammars (one grammar for colors and another for faces/buildings). The other parameters of the training phase were identical to those used in Experiment 1.

Next, participants were informed that the sequences had followed complex rules and were (surprise) tested on their implicit knowledge of one of the set of rules. Depending on their experimental condition, participants were shown 40 new strings of either faces or buildings, each without any surrounding colors. The rest of the test's parameters were identical to that of Experiment 1. Hence half of the participants were tested on a grammar instantiated by stimuli that had been made task relevant for them (faces/buildings task relevant – face/buildings grammar test) and the other half were tested on a grammar instantiated by stimuli that had been made irrelevant for them (color task relevant + faces/buildings grammar test).

### Results

As in the former experiment, the data of a participant who gave the same response in over 80% of the test trials was excluded from further analysis ($n = 1$). Next the data of participants whose grammar test scores were 2 *SD*s above or below their groups' mean were also excluded ($n = 4$).

**Comparing performance of all groups.** A 2 (Relevance: relevant, irrelevant) × 2 (Stimuli: faces, colors) ANOVA uncovered only a main effect for relevance again replicating the results of Eitam et al. (2009, 2013b), $F(1, 83) = 51.38$, $p < .001$, planned contrasts support the conclusions that the percent of correct classifications for relevant stimuli ($M = 67.03$, $SD = 12.77$) were higher than for irrelevant stimuli ($M = 50.97$, $SD = 6.93$).

**Comparing each group's performance to chance.** Differing from the pattern uncovered in Experiment 1 robust learning of the buildings and faces grammar, was evident when buildings and faces were made task relevant, $M_{\text{relevant buildings}} = 66.31\%$ $SD_{\text{relevant buildings}} = 8.47$ $t(18) = 8.39$ $p < .01$, 95% $CI_{\text{relevant buildings}}$ 62.23%–70.40%, $M_{\text{relevant buildings}} = 67.04\%$, $SD_{\text{relevant buildings}} = 15.53$ $t(23) = 5.56$ $p < .01$, 95% $CI_{\text{relevant buildings}}$ = 61.05%–74.16%, but not when they were made task irrelevant $M_{\text{irrelevant buildings}} = 51.55\%$ $SD_{\text{irrelevant buildings}} = 5.09$, $t(20) = 1.39$ $p = .18$, 95% $CI_{\text{irrelevant buildings}}$ = 49.23%–53.87%, $M_{\text{irrelevant faces}} = 50.44\%$, $SD_{\text{irrelevant faces}} = 8.35$, $t(22) < 1$, 95% $CI_{\text{irrelevant faces}}$ = 46.83%–54.05%.

### Summary

Experiment 2 failed to detect implicit learning of a grammar instantiated by buildings when these were irrelevant and also failed to detect implicit learning of irrelevant faces. Because evidence of implicit learning of irrelevant faces is theoretically important, and given the plausible assumption that the expected effect size is small (given the current experimental settings and the results of Experiment 1), we decided to run an experiment that would be sufficiently sensitive to detect learning as small as 3%.[3] If under these highly sensitive conditions we would still fail to detect reliable learning for the grammar instantiated by irrelevant faces, we would be able to accept the null hypothesis (of no implicit learning for irrelevant faces) with more confidence (e.g., Dienes, 2008).

[3] This ensured rejection of the range of values that were considered by us to be theoretically significant (3% or more) without inflation of the alpha value due to multiple testing.

## Experiment 2b: A More Sensitive Test of Implicit Learning for Irrelevant Buildings Versus Irrelevant Faces

### Method

**Participants.** Two hundred and thirty-five (235) University of Haifa students participated for either class credit or pay (156 women, *M*age = 25.13, *SD* = 14.85). They were randomly assigned to one of two conditions determined by the following procedure.

**Materials and Procedure.** This study was an exact replication of Experiment 2 but included only the irrelevant (faces/buildings) conditions.

### Results

As in the two previous experiments, the data of participants who gave the same response in over 80% of the test trials were excluded from further analysis ($n = 4$). Next the data of participants whose grammar test scores were two standard deviations above or below their groups' mean were also excluded ($n = 8$).

**Comparing performance of the two groups.** A one-way ANOVA reveled a significant effect for the test stimuli, $F(1, 221) = 5.76$, $p < .05$, with the correct classifications percent of irrelevant faces ($M = 51.3$, $SD = 6.92$) being significantly higher than of irrelevant buildings ($M = 49.08$, $SD = 6.84$).

**Comparing each group's performance to chance.** Learning was detected for irrelevant faces, $M_{\text{irrelevant faces}} = 51.3$, $SD_{irrelevant\ faces} = 6.92$, $t(110) = 1.97$, $p = .05$, 95% $CI_{\text{irrelevant faces}} = 50\%–52.60\%$, but not for irrelevant buildings $M_{\text{irrelevant buildings}} = 49.09\%$, $SD_{\text{irrelevant buildings}} = 6.84$, $t(111) = 1.42$, $p = .16$, 95% $CI_{\text{irrelevant buildings}} = 47.85–50.37$.

### Summary

A more sensitive experiment replicated the pattern of results obtained in Experiment 1 uncovering weak implicit learning for grammars instantiated by irrelevant faces. Regardless of sufficient sensitivity (for detecting an effect of at least 3% above chance performance), no such learning was detected for irrelevant buildings (see Bayesian analysis next for further consideration of sensitivity in making this claim.) To obtain a more accurate estimate of the degree of implicit learning of structures instantiated by irrelevant faces, we collapsed the data over the three experiments and tested for the learning of irrelevant faces versus irrelevant nonfaces (colors; buildings).

### Analysis Over Three Studies

**Comparing performance of all groups.** A 2 (Relevance: relevant, irrelevant) × 2 (Stimuli: faces, nonfaces) ANOVA across the data of all three experiments revealed a main effect of relevance, $F(1, 398) = 123.98$, $p < .001$, and of stimuli, $F(1, 398) = 3.93$, $p < .05$. The percent of correct classifications for relevant stimuli ($M = 62.17$, $SD = 13.1$) was significantly higher than that of irrelevant stimuli ($M = 50.38$, $SD = 7.19$). Regarding the stimuli, percent of correct classifications for faces ($M = 54.09$, $SD = 10.42$) was significantly higher than for nonface stimuli (e.g., colors and buildings; $M = 51.9$, $SD = 9.7$).

**Comparing each group's performance to chance.** No reliable learning of irrelevant nonface stimuli $M_{\text{nonface}} = 49.34\%$ $SD_{\text{nonface}} = 7.24$ $t(153) = 1.13$ $p = .26$, 95% $CI_{\text{nonface}} = 48.19\%–50.50\%$ was detected. In contrast, reliable learning was detected for irrelevant face stimuli, $M_{\text{face}} = 51.38\%$, $SD_{\text{face}} = 7.02$, $t(157) = 2.48$ $p = .01$, 95% $CI_{\text{face}} = 50.28\%–52.49\%$. Note that the confidence interval on the irrelevant nonface stimuli excludes population effects bigger than 0.5% above baseline.[4]

Another way to establish the sensitivity of the nonsignificant result (i.e., no learning of nonface stimuli) is using a Bayes factor (Dienes, 2012). Unlike a *p* value, a Bayes factor distinguishes insensitive data (Bayes factor between 1/3 and 3) from data in support of the null hypothesis (Bayes factor less than 1/3). The expectation for the size of effect for nonface stimuli, given that it exists, was modeled as a half-normal with an *SD* equal to the size of effect for face irrelevant stimuli (i.e., 1.38 above baseline), in accord with recommendations by Dienes (2012). The Bayes factor was 1/5, indicating substantial support for the null hypothesis that there is no learning of the irrelevant nonface stimuli over the alternative. A Bayes factor was also constructed for the face irrelevant stimuli. To determine roughly what effect size to expect, we used the average difference between faces and nonfaces in the relevant condition found in Experiments 1 and 2: This is 1.2%,and gives a rough estimate of the advantage enjoyed by faces in being faces.[5] Following Dienes (2011), the plausibility of different population effects given that one existed (for irrelevant face stimuli compared to baseline) was modeled as a half-normal with a *SD* of 1.2%. The Bayes factor for irrelevant faces was 10.11, very strong evidence against the null hypothesis and in favor of the theory that people could discriminate. In stark contrast to this Bayes factor, using the same assumptions, the Bayes factor for the nonface irrelevant stimuli was 0.23, virtually the same as the 0.20 calculated earlier, providing strong evidence for the null hypothesis rather than the hypothesis that people could discriminate.

[4] We are interested in testing the null hypothesis of no discrimination; hence the correct meta-analytic technique is to collapse all studies together and perform a test against the null hypothesis. When the aim is parameter estimation and a zero population difference has no special theoretical value, the possibility of different population mean differences across studies can be taken into account by, for example, assuming the different experiments had populations themselves sampled from a normal distribution (see, e.g., Cumming, 2012). As the latter technique assumes the null hypothesis of no discrimination is necessarily false, it is not appropriate for our purposes.

[5] Using the means of the relevant conditions is not an error. For calculating a Bayes Factor some sense of the effect size predicted on the alternative hypothesis is necessary. To determine how strongly evidence supports a hypothesis, one needs to know what the hypothesis predicts. However, one thing is forbidden—the very mean difference that the Bayes factor is used to evaluate (i.e., that of the irrelevant conditions) cannot be used to predict that same mean difference. So the obtained mean difference for irrelevant faces cannot be used to define the alternative's predictions. How can one estimate the advantage in processing that faces bring even in an irrelevant situation? Our ploy was to use the relevant data (this is not cheating as it is different data). So a guess at the advantage faces enjoy in being faces when they are irrelevant is the advantage faces enjoy in being faces when they are relevant. Of course it's just a guess in that relevant versus irrelevant might change everything, but all we need is a guess, and so long as it is the best guess available it is legitimate.

## Summary and Conclusions

Our results across three studies uncovered reliable implicit learning of irrelevant faces but not irrelevant colors or buildings. Although this learning is small in magnitude, the evidence for learning is robust. Hence it is a first demonstration of implicit learning for complex grammar instantiated by task irrelevant stimuli. What can we learn from these results about the role of relevance in processing faces and its role in selection for implicit learning processes?

Given that multiple studies (including the current experiments) have failed to detect any learning of complex grammars instantiated by simple (colors) and complex (buildings) nonface stimuli, the current set supports the contention that faces are, to some degree, unique in being processed regardless of their current task relevance.

With respect to implicit learning, the data show that implicit learning is sensitive to the parameters to which mere processing is sensitive (e.g., increasing interference of faces as distractors in a visual search task). It is yet to be determined whether this parameter is better understood as capture of attention or, as we have proposed, the effect that both transient relevance (e.g., relevance to the current task) and chronic relevance (of special importance to the current case) has on mental accessibility (Eitam & Higgins, 2010; see also Eitam, Yeshurun, & Hassan, 2013).

Without making too much of the current findings given the small effect-size, the fact that faces (and potentially other, socially relevant, stimuli) capture attention or have chronic relevance would make functional sense. Implicit learning is seemingly slow (Dienes, Baddeley, & Jansari, 2012), and given that people shift between many tasks during their daily routine, their implicit learning of social relations and other cross-situationally (i.e., chronicly) relevant relationships (e.g., tonal inflections for Chinese speakers, Guo et al., 2013) would be rather limited if such learning occurred only on current task-relevant stimuli. We can only speculate that such weak learning can accumulate to a substantial knowledge base during the years of an individual's course of development; hence, implicit learning may be found to play a significant role in social functioning.

Yet, whether social behavior itself depends on implicit learning is an open question, as this issue has received virtually no empirical attention. If established that it does, then the variance between populations in assignment of relevance to faces, such as people low versus high on the ASD spectrum, could help explain the social difficulties that members of some populations experience.

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