Stereotypes Can Be Learned through Implicit Associations or Explicit Rules

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Dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Psychology and Neuroscience in the Graduate School of Duke University

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ABSTRACT

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Abstract

Two studies examined whether stereotypes can be created using different learning paradigms and whether the resulting stereotypes will have different properties that affect their activation, suppression, and explicit knowledge. In the Pilot Study, participants were able to learn to use clothing cues to predict membership using both an explicit paradigm that made declarative statements of group membership and an implicit paradigm based on feedback learning. In Study 1, implicit learners performed worse after a depletion task and better following a control task. The stereotype strength of explicit learners did not change based on the depletion task. High trait self-control as measured by the Brief Self-Control Scale was shown to predict better performance in depleted explicit learners and worse performance in depleted implicit learners. In Study 2, participants in both the implicit and explicit learning conditions saw decreases in performance when trying to inhibit a previously learned cue. Trait self-control did not predict the ability to suppress the use of a specific cue. In both studies implicit learners made more accurate estimations of the cue probabilities, suggesting a stronger explicit knowledge of the relationship between the cues and group membership. These results provide initial evidence that the method of stereotype learning can have an impact on later stereotype usage although the mechanisms that lead to these differences require additional research.
Dedication

To my parents, Frank and Mary, who taught me the important things that allowed me to learn everything else.
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1. Introduction

Imagine starting your freshman year at a large university. In the first week, you are warned several times that you should avoid players on the football team, as they are all physically intimidating and act aggressively. Although you never see any members of the football team in your classes or around campus, you try to remember what you have been told. During this time, you have been taking a short-cut through the psychology building every day, and you cannot help noticing that psychology students are always trying to get you to take part in their studies. Nobody warned you about this, but you have started to expect it whenever you see one of them.

This scenario goes on every day, not just on college campuses but everywhere in the world. People develop stereotypes through a variety of means. Sometimes stereotypes develop through information that has been provided to people, sometimes they learn about a group from watching television, and other times they develop their own impressions from repeated interactions. Although the result of each process is a stereotype, questions remain about the ramifications of the methods by which stereotypes develop for stereotype activation, inhibition, and change.

The following studies propose a basic mechanism, based on social psychological theories of two processing modes and work in neuroscience on dual memory systems, for learning implicit and explicit stereotypes using a probabilistic learning paradigm. One processing mode is proposed to facilitate stereotype development through an implicit process, resulting in primarily implicit stereotypes, and the other through an
explicit process, resulting in primarily explicit stereotypes. A Pilot Study was conducted to test the efficacy of a probabilistic learning paradigm for developing implicit and explicit associations between visual cues and group membership. Two additional studies were used to compare the resulting implicitly and explicitly learned associations with what is known about the differential functioning of implicit and explicit stereotypes. Specifically, these studies examine whether explicitly and implicitly learned associations function differentially when an individual is depleted of self-regulatory control and when an individual is asked to ignore the meaning of a previously learned membership cue.

1.1 Stereotype Learning

To define stereotypes, I borrow from Schneider’s (2004) description of stereotypes as “qualities perceived to be associated with particular groups or categories of people” (p 24). Stereotypes are easily observed and measured, but the processes by which people learn stereotypes are complex and not well understood at present. One issue is that stereotype learning is not a planned activity, so it can rarely be observed as it occurs in the real world. Stereotype learning is not always a conscious process, and individuals can rarely recall the processes that led to the development of their stereotypes. In addition, people hold stereotypes for groups that they have never encountered themselves, suggesting that the information leading to stereotypes is often verbal or written communication. This cultural transmission of stereotypes from parents, friends, and media make determining the source of stereotypes all the more difficult. The result of these issues is that the content, strength, and activation of existing
stereotypes have been the major focus of most of the stereotyping literature, and researchers have paid less attention to stereotype learning.

Work on stereotype acquisition has traditionally focused on the motivations for stereotype acquisition, such as in-group – out-group interactions or the forming of inaccurate stereotypes as in the case of illusory correlations. By treating stereotypes as motivated cognitions that lead to discrimination and prejudice, one of the underlying mechanisms, pattern recognition, has remained largely unexplored within this field. In the rush to point out the issues associated with of stereotype formation, focusing on the flaws and negative aspects of stereotyping, researchers have ignored how individuals use information about groups to learn accurate stereotypes.

The phrase “accurate stereotypes” is by itself somewhat misleading. Stereotypes have often been defined by their accuracy, or more specifically their lack-thereof. Some researchers and academics believe that stereotypes are by definition an over-estimation of the probability of a characteristic within a group of people. However, this means that accurate beliefs would no longer count as stereotypes, even if they are a generalization about a group of people.

The focus of the present research is on stereotype accuracy as a function of learning style. By creating stereotypes in the lab the actual frequency of the characteristic in the population is known and all participants are seeing the same information. In the real world, different people will have been exposed to different stimuli and we cannot determine whether a stereotype is accurate based on their own experience, only whether it is accurate compared to the population in question.
The present research is also intended to remove much of the motivation that leads to stereotyping. By presenting brand new targets and groups there should be no existing stereotypes and no reason to feel positively or negatively about the new groups or their characteristics. The associations learned between the target and the cues will be unmotivated pattern recognition between a group of people and their characteristics. The associations between a group of people and characteristics that describe that group will be learned, creating a basic stereotype, but the hard to understand motivations and attitudes will play no role in the learning process.

1.2 Attitude Learning and Classical Conditioning

Research on the learning of stereotypes has often been divided into a cognitive approach and a motivated approach (Macrae, Stangor and Hewstone 1996). The cognitive approach considers the cognitive benefits of using stereotypes, while the motivated approach considers the benefits to self-esteem and positive emotions. However, the vast majority of research on stereotype learning focuses on motivated reasons for stereotype learning (in-group preferences, out-group homogeneity, etc.) with much less attention paid to the cognitive mechanisms of stereotype learning. This is in stark contrast to the literature on attitude learning, which has the benefit of a rich history of classical and operant conditioning research.

Attitude learning has deep roots in psychological research, starting with the classical conditioning of attitudes. Classical conditioning has been demonstrated as a reliable method for developing attitudes towards a neutral target. By repeatedly pairing a conditioned stimulus with one or more unconditioned stimuli, the meaning of the
unconditioned stimuli can be transferred to the conditioned stimulus (Staats and Staats 1958; Levey and Martin 1975). Operant conditioning, the pairing of an unconditioned stimulus to a positive or negative outcome, can lead to a similar attitude change using feedback to create a positive or negative outcome. Insko and Cialdini (1969) were able to change participants’ stated beliefs regarding “pay TV” by verbally reinforcing statements that participants had made previously.

Subsequent research has demonstrated that conditioning can be effective even when participants are not consciously aware of the change in their attitudes, either because they could not keep track of the attitude objects (Olson and Fazio 2001) or because the unconditioned stimulus was subliminal (Krosnick, Betz, Jussim and Lynn 1992). Rydell, McConnell, Mackie and Strain (2006) found that subliminal information changed implicit attitudes but not explicit attitudes, whereas consciously accessible information changed only explicit attitudes.

Attitude learning is not limited to associative learning. Prislin, Wood and Poole (1998) found that specific attitudes were often formed to be consistent with more general existing attitudes. For example, McConnell, Rydell, Strain and Mackie (2008) demonstrated that in the absence of specific behavioral information about a particular individual, attitudes towards that individual can be generated by transferring the attitude about relevant traits (e.g. race or physical characteristics) to the individual. Unfortunately, this paradigm does not reveal the initial development of the attitude towards the trait; instead, it demonstrates the application of the attitude from the group to the individual.
1.3 Dual Process Models of Learning and Memory

The extensive work on the cognitive processes behind attitude learning has not led to similar work on stereotype development. Instead, most work on stereotypes has focused on already-learned and often well-known stereotypes. It is important to understand the processes by which stereotypes are learned because so much work has gone into classifying stereotypes as implicit or explicit and has demonstrated that the two types of stereotypes function differentially. Explicit stereotypes are those that are available to consciousness and that can be reported by the individual. Explicit stereotypes require attention and are considered to be controllable, effortful, and easily suppressed. Implicit stereotypes require minimal attention and are not consciously accessible to the individual. These stereotypes are automatic, efficient, uncontrollable, and difficult to suppress (Moors and De Houwer 2006). Implicit and explicit attitudes can both affect behavior, with explicit attitudes more likely to be used when motivation and mental energy are high. The differences in activation, and the fact that implicit and explicit stereotypes can differ within the same individual, suggest that they may rely on separate memory systems.

In light of the distinction between explicit and implicit stereotypes, dual-process models offer a potential basis for this distinction. Dual-process theories generally describe the interaction of an automatic, association-based system with a more thoughtful, consciously applied system of processing. Sloman (1996) and Smith and DeCoster (2000) proposed the dual-process modes as a means of combining the previous dual-process theories in social psychology. The theory describes an associative mode
and a rule-following mode. The differences in these modes are tied to distinct memory systems, specifically to a slow-learning system and a fast learning system. The slow-learning system is intended to remain stable and to take into account every experience, changing incrementally with each relevant instance of the situation. The fast-learning system can change quickly, in some cases learning information the first time it is encountered. These memory systems are accessed by two processing modes that use the memory systems in different ways. The associative processing mode only uses the slow-learning system and can act quickly and automatically to fill in information based on previous associations. The rule-based processing mode can use the fast-learning system as well as the slow-learning system and relies on symbolically represented knowledge. This system is effortful and must be intentionally applied.

1.4 Stereotype Learning

Rydell and McConnell (2006) proposed a systems of evaluation approach to implicit and explicit attitudes, suggesting that implicit attitudes operate according to the associative system and that explicit attitudes function according to the rule-based system (see also the APE, Gawronski and Bodenhausen 2006). This perspective has not been applied to stereotype learning or usage, but considering stereotypes under this dual-process system provides an opportunity to examine the role of stereotype learning as it relates to stereotype use and the interplay between implicit and explicit stereotypes. Social psychologists have developed mechanisms for assessing implicit attitudes independently of explicit stereotypes but have not developed paradigms for how the learning these two types of stereotypes may occur independently of one another.
When using conditioning to create stereotypes, participants are provided with a list of positive and negative behaviors performed by members of each group (Rothbart, Fulero, Jensen, Howard and Birrell 1978). If members of one group are repeatedly paired with one type of behavior (positive or negative) for a specific trait (e.g. friendliness or intelligence), the underlying meaning of the behaviors becomes associated with group membership. For example, if several members of Group A did poorly on a test, members of Group A will come to be seen as unintelligent. Although this method is associative, it is likely creating both implicit and explicit stereotypes. The repetition of the target and the characteristics builds the slow-learning system, each example making an incremental change to the relationship. However, because the participant can consciously recall and reflect on these frequencies, this method of learning is also creating rule-based relationships. A similar phenomenon has been noted in work on classical conditioning, with concerns that participants are aware of the contingency relationships and make their responses based on this awareness instead of using their newly developed attitudes (Page 1969; Page 1974). In the case of stereotypes, participants using this method of learning may possess both implicit and explicit beliefs about the target group that are congruent and cannot be functionally separated. Any response could be the result of implicit, explicit, or even a combination of both stereotypes. To compare implicit and explicit stereotypes carefully, we need a mechanism for developing one type of stereotype in the absence of the other.
1.5 Procedural vs. Declarative Learning

Research paradigms that allow direct comparison of the explicit learning of classification rules and implicit learning of associations can be found in probabilistic learning tasks used in neuroscience, such as the weather prediction task (Knowlton, Squire and Gluck 1994; Knowlton, Mangels and Squire 1996). In this task, participants are taught to use visual cues as the basis for determining category membership, in a manner similar to the way in which stereotypic attributes of individuals are likely used to predict group membership. In the typical version of the weather prediction task, the cues are tarot cards with different shapes on them, and participants are shown between one and three cards and asked to predict a rain or shine weather outcome. The associations between the cues and predicted category are probabilistic, meaning that the characteristics displayed are only partially indicative of the category, just as they would be when using stereotypic categories in real life.

A unique feature of this work is that the procedures in the learning task can be modified to promote either explicit learning of rules about category membership or implicit learning of associations. Learning is differentiated into observational and feedback based schemes, each of which use different procedures but result in similar recall success. With the observational learning procedure, the characteristics and category are presented at the same time, allowing for the explicit learning of a rule structure that reflects the strength of the association between the group and the trait. Participants create and test rules during the learning phase that can be used later to determine group membership in the testing phase.
A second, feedback-based method of learning is believed to develop implicit knowledge about category membership. In this procedure, participants learn based on feedback that is given after they have guessed the category indicating whether their guess was right or wrong. Through trial and error, participants gain implicit knowledge of category membership after the feedback has been received. This type of memory is considered to be automatic and non-conscious in the sense that individuals typically are unable to put their knowledge into words. To ensure that this learning does not involve conscious deliberation, participants often are given a cognitive load task during learning that reduces their ability to acquire explicit rules about the associations between the cues and the outcomes (Foerde, Knowlton and Poldrack 2006). For the purposes of stereotype research, cognitive load would also make it difficult for participants to consciously track the strength of the association between characteristics and categories.

Following the learning trials, participants go through a series of test trials in which they are shown a pattern of cues and respond with the most likely category. Research has demonstrated that participants in both observational and feedback learning conditions learn to predict category outcomes at relatively equal rates, suggesting that learning is taking place using both methods. However, the differences in learning methods result in different cognitive representations of the cues. Observationally-learned cues are rule-based, resulting in more flexible knowledge about the meaning of the cue and the ability to think about the relationship between the cue and the outcome. For example, participants in the observational learning condition are more accurate than those in the feedback learning condition when estimating the
outcome probability of each cue and when picking the cue most likely to be present
given a specific outcome (Foerde et al. 2006).

Additional evidence that these two learning procedures establish different types
of learning, one more explicit based on knowledge of rules and the other more implicit
based on associative knowledge, comes from research using fMRI to analyze neural
activation within the brain as learning occurs. Foerde et al. (2006) found that
observational learning activates the medial temporal lobe (MTL), the region involved in
rule-based observational memory and the location of the hippocampus, necessary for
the creation of new episodic memories. Poldrack et al. (2001) suggested that the medial
temporal lobe is more likely to be used early in learning and less so as learning
continues. In contrast, feedback learning implicates the striatum and the basal ganglia,
the site of habit-based feedback memory (Knowlton et al. 1994; Poldrack et al. 2001;
Moody, Bookheimer, Vanek and Knowlton 2004; Foerde et al. 2006). The neostriatum is
important for gradual association learning, not just motor learning but for tendencies
and dispositions as well (Knowlton, Mangels and Squire, 1996; Shohamy et al. 2004).
Specifically, the neostriatum seems to activate during habit learning, suggesting that
feedback learning creates a categorization habit in participants that is not seen with
observational learning.

Studies comparing the performance of persons with specific neurological
impairments to that of neurologically healthy individuals also suggest two distinct types
of learning (Knowlton et al. 1996; Shohamy, Myers, Grossman, Sage, Gluck and Poldrack
cannot form new memories have difficulty with observational learning. However, these patients perform the task just as well as healthy individuals when they learn to predict the weather through feedback learning. In contrast, Parkinson’s patients are able to learn new observational knowledge but demonstrate deficits in feedback learning. Although they can learn new rules for categorization, they do not reap the benefits of the feedback that they receive from their actions.

The basic procedures in the weather prediction task have previously been modified to involve cues other than tarot cards. For example, Shohamy et al. (2004) used the popular children’s toy “Mr. Potatohead” as the target for decision-making. By altering the doll’s appearance with the addition of facial features, participants were given probabilistic cues that predicted a preference for ice cream flavor, keeping the same dichotomous probability by limiting the options to chocolate and vanilla.

I suggest that if the weather prediction paradigm can be used to learn how to predict the characteristics of a doll, it can be used to learn to predict the characteristics of a person as well. Predicting unobservable traits, such as intelligence, from visible cues, such as skin color, is at the heart of stereotype use. The weather prediction task may provide a mechanism for creating stereotypes that are mostly explicit or mostly implicit, potentially allowing for testing of the unique characteristics of each type of stereotype. Because these stereotypes are being created from scratch, observational learning would likely create an explicit stereotype with only a minimal, limited representation of an implicit stereotype, thereby allowing for the measurement of explicit stereotype effects without competition or interference from implicit stereotypes. Feedback learning would
likely create an implicit stereotype with only a minimal, limited representation of an 
explicit stereotype. These circumstances provide an opportunity to explore some of the 
underlying mechanisms that support the activation and inhibition of explicit and 
implicit stereotypes. This method also creates unmotivated stereotypes, both implicit 
and explicit, without concerns for previous experiences, attitudes, or prejudices.

1.6 Self-Regulation and Stereotyping

Although stereotypes are a valuable heuristic by which perceivers can make 
quick and efficient judgments, they are generalizations and rarely accurate. Even in 
cases where the stereotype is accurate of the group as a whole, they are not necessarily 
accurate for specific individuals. To avoid making errors or seeming to over generalize, 
people may try to avoid using stereotypes in their daily lives. Several methods for 
proactively inhibiting stereotypes have been demonstrated. For example, the activation 
of egalitarian goals can lead to implicit inhibition of stereotypes, blocking stereotypes 
before the perceiver is aware of them (Moskowitz and Li 2010). Alternatively, implicit 
evaluative conditioning can be used to reduce automatically activated attitudes (Olson 
and Fazio 2006). In other cases, the perceiver may be unaware of the stereotyping risk 
until after the stereotype has already been triggered, resulting in a conflict between the 
activated information and the desired behavior. When this occurs, individuals may 
consciously attempt to control their stereotypes, making corrections to their behavior in 
order to act according to their explicit beliefs (see Devine and Monteith 1999).

The process of stereotype inhibition can be surprisingly complicated. To ignore 
the meaning of a cue, a perceiver must know what that cue meant in the first place. If
trying to avoid stereotyping girls as worse in math, the perceiver must know how much worse girls are believed to be before adjusting for their stereotypes. These naïve theories about cue meaning and the degree to which they bias judgment are the basis for correction (Wegener and Petty 1997). Explicit stereotypes have several properties that are expected to make this process easier. The rule-based nature of explicit stereotypes and conscious recognition of the relevant cues means that the perceiver is aware of the stereotype and has access to the rules related to the stereotype in question. They should be able to make adjustments based on these rules, effectively negating the effects of the cue. Implicit stereotypes present a challenge to inhibition because the perceiver may be unaware of the meaning of the cues and does not consciously know how strongly they predict the stereotype. Without knowing how much of an adjustment to make to counteract the effects of stereotype activation, the perceiver is likely to under- or over-correct for the stereotype.

1.7 Stereotype Activation

Stereotyping is often portrayed as an automatic process that saves the perceiver the time and effort of making a more careful judgment (see Macrae, Milne and Bodenhausen 1994). Research has also demonstrated that stereotypes act as a fall-back position when cognitive or attentional resources are low and a logical, well-reasoned analysis is impossible. Bodenhausen (1990) was able to demonstrate that stereotypical judgments are predicted by circadian rhythms, finding that individuals who reported that they were more alert in the morning relied more on stereotypes in the evening while self-reported evening people were more likely to use stereotypes in the morning.
reflecting daily fluctuations in the level of arousal for each group. Studies on attentional resources have found that perceivers whose attention is otherwise engaged are more likely to recall stereotypic information about a target compared with those who are not distracted by another task (Stangor and Duan 1991; Macrae, Hewstone and Griffiths 1993; Pendry 1998).

The self-regulatory resource also plays a role in stereotyping. Resource depletion results from actively attempting to control our responses, typically in an effort to bring about desired outcomes. As the resource is depleted, subsequent acts of self-control become more difficult to perform until the resource can be replenished (Muraven and Baumeister 2000; Muraven, Tice and Baumeister 1998).

The argument that a lack of resources increases stereotyping assumes that all stereotypes are conscious and effortful. Whereas implicit stereotypes are automatic and can be learned and activated with few resources, explicit stereotypes rely on cognitive systems that require more attention and focus. If explicit stereotypes require the same resources for activation that are involved in logical reasoning, then the same conditions that lead to the increased use of implicit stereotypes may preclude the use of explicit stereotypes.

It may be that both implicit and explicit stereotypes are activated, but with fewer resources the perceiver automatically uses their implicit stereotypes. Self-regulatory resource depletion provides an opportunity to test whether a lack of resources prohibits explicit but not implicit stereotype activation. Resource depletion not only affects the ability to inhibit responses, but it also leads to impairment on intellectual performance
tasks and a reduced ability to focus (Schmeichel, Vohs and Baumeister 2003). No such
effect is demonstrated on performance at simpler, less cognitively demanding tasks.
Thus, self-regulatory resource depletion should predict stereotype activation such that
perceivers rely more on implicit stereotypes. People are likely to use implicit stereotypes
when depleted because cognitive resources aren’t available to access the more resource-
consuming explicit stereotypes. Implicit stereotypes use fewer resources thus their
expression/use is not impaired when under cognitive load.

1.8 The Current Research

The studies presented here test whether stereotypes can develop through two
learning processes, one involving the implicit learning of probabilistic associations
among cues to individuals’ group membership through trial-and-error judgments with
feedback, and the other involving the more explicit learning of decision rules about
individuals’ group membership. Two lab studies were conducted to identify and
evaluate the nature of these two types of stereotype learning.

A pilot study measuring stereotype learning was conducted to establish the
viability of the learning procedures and to and to demonstrate that stereotypes of
comparable strength result from the two learning strategies. Two follow-up studies
evaluate differences in the characteristics of the knowledge gained through the two
stereotype learning strategies. Study 1 examines the effects of depleting participants’
self-regulatory resources prior to measuring the strength of stereotypes that were
learned either explicitly or implicitly. Study 2 tests whether participants are able to
inhibit or ignore one of the probabilistic cues when making a categorization.
Participants in the pilot study learned to stereotype a target through explicit or implicit means, using articles of clothing as a probabilistic cue. Participants in the explicit learning condition were simultaneously shown a target and the target’s group membership—whether they belonged to a “friendly” or “unfriendly” group. Participants in the implicit learning condition were shown the target and guessed the target’s group. After guessing, the participants received feedback on whether their guess was correct or incorrect. To make sure that learning was implicit, participants in the feedback learning condition counted tones as they learned. The tone counting task was intended to distract participants, preventing them from consciously remembering the trials. Following 100 trials and 150 trials, participants completed 28 trials in which they stated whether they believed that the target was friendly or unfriendly. Participants’ beliefs for each trial were coded as congruent if their responses aligned with the probabilities from the learning phase and incongruent if they were not aligned with the probabilities. The number of times that their response was congruent was summed to produce a score for the strength of participant’s associations. The learning manipulation would be successful if participants in both explicit and implicit learning conditions were more likely than chance to categorize the target into the group that they had appeared in more often during the learning trials. This would suggest that they had learned to use the cues to make a stereotypic judgment of the target. Furthermore, if the procedure was set up correctly, participants in the two conditions would not differ in their ability to learn the stereotypes.
Following the second testing phase, participants completed a version of the Affect Misattribution Procedure (AMP) to determine whether their associations between the cues and group membership also changed their affect towards the targets (Payne, Cheng, Govorun and Stewart 2005). The learned stereotypes identified the target as friendly or unfriendly, and it is possible that these positive or negative descriptors altered the way participants felt about the targets. If participants in both conditions have equivalent feelings about the targets, we can rule out differences in affect as the cause of any effects.

In Study 1, we tested whether self-regulatory resource depletion affects the ability to categorize a target differently if the relationships between the cues and group membership are learned through observational or feedback-based learning. Following the procedure of the pilot study, participants completed 100 learning trials using either an explicit or implicit learning paradigm. Participants then completed an initial testing phase of 28 trials. Prior to a second testing phase, some participants performed a depleting task, whereas participants in the control condition performed a similar task that did not deplete the self-regulatory resource. Stereotype strength was measured for trials before the depleting task and for trials after the depleting task.

Hypothesis 1: Stereotypes that are learned explicitly will be weakened by self-regulatory resource depletion because participants will have reduced ability to consciously apply the rules they developed for categorization. Stereotypes that are learned implicitly will be expressed just as strongly under depletion (vs. no depletion) because use of implicit stereotypes requires less conscious deliberation about a target.
Study 1 also measured the stereotypes that participants developed through implicit and explicit learning, using measurements of explicit and implicit stereotypes used in previous research. In one measurement task, participants were shown the target and estimated the likelihood that the target belonged to a specific group based on his clothing.

**Hypothesis 2**: Participants in the explicit learning condition are expected to be more accurate when estimating the likelihood of group membership compared with participants in the implicit learning condition.

In Study 2, we tested participants’ ability to suppress explicitly and implicitly learned cues when predicting group membership. Participants learned to predict group membership as in Study 1 and thereby developed implicit or explicit group stereotypes. During the initial testing phase, participants predicted the group membership of the target individuals that they saw during the learning phase. Prior to the second testing phase, participants were told that one cue was adopted by both groups and was no longer a reliable indicator of group membership. In order to categorize the targets, participants should have only used the remaining three viable cues, ignoring the cue that had been nullified. Participants in the explicit learning condition, who had developed rules for using each cue, were expected to have little difficulty in using only the other cues. However, participants in the implicit learning condition were expected to have trouble ignoring the cue, as they may not consciously understand what it predicts and therefore cannot exclude its influence on their categorization of the target.
Hypothesis 3: When stereotypes are learned implicitly, participants will have limited ability to intentionally control their stereotype knowledge, as represented by ignoring cues when told that the cues no longer matter.
2. Pilot Study

2.1 Overview

The Pilot Study determined whether the probabilistic learning paradigm can be adapted to create implicit and explicit stereotypes towards individual targets. Participants first learned to make a stereotypic judgment of the group membership of a target individual by using the target’s clothing as a means of determining whether the target belonged to a group that was friendly or unfriendly. Previous probabilistic learning tasks have used 100 learning trials (Foerde, Knowlton and Poldrack 2006) to ensure that participants learned the task. These prior tasks used simple cues (e.g. symbols on tarot cards) to identify weather patterns (rain or sunshine). Because the Pilot Study used a different type of target (people) and a different set of cues (clothing and accessories), it was necessary to determine the number of trials required for participants to learn the stereotypes. Learning was measured using 28 testing trials after the first 100 learning trials and another 28 testing trials after an additional 50 learning trials. Evidence of stereotype learning would be demonstrated by participants making judgments of group membership that correspond to group membership likelihood during the learning phase at a rate greater than chance.

One potential confound in interpreting the stereotype finding is that participants in one learning condition may differ in affect towards the target as the result of the learning paradigm. To assess implicit affect towards the target, participants completed a version of the Affect Misattribution Procedure (Payne et al. 2005). Congruent responses
were defined as preferring targets more likely to belong to a friendly group and rejecting targets more likely to belong to an unfriendly group. Participants were expected to make a congruent response at a rate no greater than chance. Although they are learning to categorize the targets into groups that have positive and negative qualities, participants are not expected to use these qualities to form affective judgments of the targets. Participants rated 28 targets with each pattern of clothing cues used twice.

2.2 Method

2.2.1 Participants

Forty-nine students (38 women) from the University of Northern Colorado participated in the study for partial research credit in their psychology course.

2.2.2 Procedure

Participants were randomly assigned to the explicit or implicit learning condition when they entered the lab. They were seated in front of a computer and were told that the entire task would take place on the computer. The program provided instructions, recorded their responses, and gave rest breaks. All participants wore headphones during the task.

The first task was to complete 150 implicit or explicit learning trials, according to the assigned condition. In the explicit learning condition, participants were shown a target person and were told the group to which the target belonged. After the first 100 learning trials (Phase 1), participants performed 28 trials measuring how well they categorized each target, according to the likelihood of group membership. Each set of
cues was shown twice. Participants then completed another 50 learning trials (Phase 2) before performing another 28-trial test.

During implicit learning trials, participants counted high and low tones that they heard following their response. A tone played for 1 second at either 500hz or 1000hz while the correct answer was displayed. Participants kept track of the tones for five trials at a time. After the fifth trial they chose the correct number of high frequency tones that they heard from a list of two choices. Participants then began to count tones again starting from zero. The feedback learning condition followed the same structure as the observational condition with 100 learning trials (Phase 1), 24 testing trials, 50 learning trials (Phase 2), and finally 24 more learning trials.

Following the learning phase, participants completed the modified version of the AMP. Participants saw pairs of pictures flashed one after the other, the first one being a background image and the second being a Chinese character. Participants were told that the background image serves as a warning signal for the Chinese character. Participants then decided whether they liked the character more or less than average. Participants were instructed to press the “q” key if they liked the symbol more than average and to press the “p” key if they liked the symbol less than average. All 14 combinations of cues were used as the prime twice for a total of 28 trials. During each trial of the priming task, the prime image appeared in the center of the screen for 75 ms, followed by a blank screen for 125 ms, and then a Chinese pictograph for 100 ms. Following the pictograph, a pattern mask consisting of black and white “noise” appeared until the participant
responds. Participants’ responses were recorded. The task lasted approximately three minutes.

2.2.2.1 Stereotype learning task

This task was used to manipulate the predominant learning system by which participants learned stereotypes. The procedure for this task closely matches that of the weather prediction task (Poldrack et al. 2001). Across 150 learning trials, participants were shown a target individual and were told which group he belonged to, either the friendly or the unfriendly group. The information is structured so that the target’s group membership is probabilistically related to the clothing he is wearing. Four different pieces of clothing were used, which when combined formed 14 unique stimulus patterns using up to three pieces of clothing at a time.

Associations between stimulus patterns and group membership were probabilistic and identical to those used by Knowlton, Squire and Gluck (1994; see Appendix 3). The learning conditions modulate the relative, but not absolute, engagement of each type of memory; such that participants acquire some task knowledge in both forms of memory with the quality of learning simply tilted predominantly towards observational (explicit) or feedback-based (implicit) memory systems (Meeter, Myers, Shohamy, Hopkins and Gluck 2006).

2.2.2.2 Implicitly learned stereotypes

In the implicit learning condition, participants were shown the target in each trial for 0.5 seconds before two choice options (friendly or unfriendly) appeared on the screen below the target. They then had 2.5 seconds to choose the group membership of the
target. After the participant made a selection (or after 2.5 seconds if the participant fails to choose), the target’s group was displayed above the target for 1 second.

In previous studies, cognitive load has been shown to encourage reliance on feedback learning (Foerde, Knowlton and Poldrack 2006). Cognitive load is believed to block the ability to learn explicit knowledge because participants cannot consciously process the information. In this study, participants in the implicit-learning condition counted high-pitched (1000 hz) versus low-pitched (500 hz) auditory tones during the task. The added load of counting tones has been found to reduce explicit learning during implicit learning trials, producing knowledge that is primarily learned through feedback (Shohamy et al. 2004). Participants were told prior to each feedback learning block of five trials that they must keep track of the number of high-pitched tones that they hear. Following each feedback block, participants indicated between two choices how many high-pitched tones they heard.

### 2.2.2.3 Explicit learning of stereotypes.

In the explicit learning condition, which promotes the formation of stereotypes based on explicit decision rules, participants were shown each target for 2.5 seconds with the group name appearing above the stimulus pattern the entire time the target is presented. Participants in the explicit learning condition heard the tones but did not count tones. Instead, after every five trials they chose the larger of two single digit numbers unrelated to the number of tones. This task was intended to be easy but to take the same amount of time as indicating the correct number of tones in the feedback learning task. The inter-trial interval in both learning conditions was 0.5 seconds.
2.2.2.4 Affective measure of participant attitudes

In the final task, participants completed the AMP to determine if the learning task had created attitudes as well as stereotypes of the targets. The AMP uses participants' affective ratings of a neutral prime (e.g., a Chinese symbol) following exposure to a subliminal prime (such as African American versus Caucasian faces). In this study, the subliminal prime consisted of pictures of the target. Neutral primes consisted of Chinese pictographs as in the original study. Participants rated each symbol as more or less likeable than average. These judgments are unconsciously influenced by the subliminal prime preceding the Chinese symbol. This task thereby measures participants' affect towards the target (Payne et al. 2005).

2.3 Results and Discussion

Performance measured after the first 100 trials suggested that participants were learning to predict the target’s group membership based on clothing cues. Overall, participants were correct on 59% of the testing trials. This score was found to be significantly better than chance, $t(48) = 28.80, p < .001$, suggesting that participants had developed stereotypes for the targets based on their clothing. After 150 learning trials, participants were correct 62% of the time, also a rate greater than chance, $t(48) = 29.11, p < .001$.

Participant ratings were also compared across conditions to determine whether participants were learning at the same rate in both conditions. During the first set of
testing trials, participants in the feedback condition ($M = 60\%$) made congruent responses at a rate similar to those in the observational condition ($M = 58\%$), $t(47) = -0.50$, $p = .62$. The same results were found for the second set of testing trials, in which participants in the feedback condition ($M = 60\%$) made congruent responses at a rate similar to those in the observational condition ($M = 63\%$), $t(47) = 0.61$, $p = .55$.

An additional analysis was run comparing the response times of participants between conditions. Response times were measured in milliseconds and were averaged for each participant. As participants had a limited time to respond, trials in which time ran out were not used as part of this analysis. For learning phase 1, participants in the feedback learning condition ($M = 1135$ ms) responded significantly faster on average than participants in the observational learning condition ($M = 1293$ ms), $t(47) = 2.09$, $p = .04$. For learning phase 2, no difference was found for the average response time between participants in the feedback learning condition ($M = 1137$ ms) and observational learning condition ($M = 1217$ ms), $t(47) = 0.84$, $p = .41$.

The AMP was used to analyze whether participant affect was different depending on the learning paradigm used to learn group membership. Due to computer failure, the AMP results of two participants could not be included. Responses were considered congruent if participants rated the pictograph positively when the target was more likely to be friendly and negatively when the target was more likely to be unfriendly. Otherwise, responses were considered to be incongruent. Overall, responses were congruent for 48% of the trials. To determine whether this effect may be present for participants with stronger associations between the cues and group membership, this
analysis was re-run including only participants who had demonstrated the greatest stereotype strength during the second testing phase, defined as scoring over 60% on the second learning phase. Although these participants have a better understanding of the predictors of group membership, they made congruent response at a rate of only 49% of the time on the AMP task. For all participants, there was no difference between conditions for learning style, $t(44)=0.14$, $p = .89$, with participants in the feedback condition making congruent responses 49% of the time and participants in the observational condition making congruent responses 48% of the time.

The results of the pilot study demonstrated that participants can successfully categorize a target using clothing as the cues for determining group membership. In both the explicit learning and implicit learning conditions, participants were more likely to categorize the target into the group in which he had belonged most often in the learning trials. This suggests that both learning procedures were effective in teaching the probabilistic learning task.
3. Study 1

3.1 Overview

Study 1 tested how explicitly and implicitly learned stereotypes function when participants experience self-regulatory depletion. Explicit stereotypes, which rely on rule-based learning, were expected be more difficult to apply when depleted. Cognitive resources are required to implement these stereotypes, especially to allocate sufficient attention to notice and interpret the important cues and to choose the correct rules. Thus, individuals are expected to rely less on explicit stereotypes when regulatory resources are low. Implicit stereotypes, which are developed through feedback, were expected to require fewer cognitive resources and thus be easier to apply when depleted. Implicit stereotypes are considered to be less effortful and automatic and thus are less dependent on cognitive resources and willpower.

To test this possibility, participants completed a version of the e-crossing task, which has been used in previous research as a method for depleting self-regulatory resources (Baumeister, Bratslavsky, Muraven and Tice 1998, Study 4). Some participants from both the implicit and explicit learning conditions performed a depleting version of the task. The depleting version was expected to make it more difficult to apply explicitly learned stereotypes, reducing the use of these stereotypes when predicting group membership. However, the depletion manipulation was expected to increase the use of implicitly learned stereotypes, given that these stereotypes are automatic and require fewer cognitive and attentional resources. When both stereotypes are present, there is a
degree of competition between implicit and explicit stereotypes. A decrease in explicit stereotype activation would lead to an increased reliance on implicit attitudes. Participants in the explicit learning condition, with no implicit stereotypes to fall back on, will likely have trouble accurately using the cues to make group judgments. Participants in the implicit learning condition, who have fewer explicit stereotypes but may rely on them anyway, would have to rely on their stronger, more accurate implicit stereotypes and would see improved performance on the grouping task.

Explicit Knowledge task. Participants also performed a task used in previous research to measure explicit stereotype strength. In the Percentage Task, participants rated the likelihood that the target individual belonged to one of the groups. This task indicates whether participants understand the probabilistic nature of the stereotype. Instead of developing a simple yes/no categorization, participants with greater explicit knowledge of the cues are expected to better recall the likelihood that each cue indicates group membership prior to making a choice.

Chronic self-control capacity. Additionally, participants completed an individual trait measure related to the experimental tasks. The Brief Self-Control Scale (Tangney, Baumeister and Boone 2004) measures one’s capacity for self-control (see Appendix 4). Individuals who score high on self-control using this measure have been shown to have better self-control and impulse control, leading to preferred life outcomes. As participants were asked to perform a depleting task during the second phase of the study, scores on the Brief Self-Control Scale were used to control for chronic, individual differences in self-control capacity.
3.2 Method

3.2.1 Participants

One-hundred thirty-five students (99 women) from the University of Northern Colorado participated in the study for partial research credit in their psychology course.

3.2.2 Procedure

3.2.2.1 Brief Self-Control Scale

Participants first completed a version of the Brief Self-Control scale (Tangney, Baumeister and Boone 2004) on the computer. The scale is composed of 13 statements meant to assess trait-level self-control. Participants were asked to choose how well each statement describes their lives on a five point scale from 1 (Not at all) to 5 (Very much).

3.2.2.2 Stereotype Formation Task

Participants then completed 100 learning trials in either the explicit learning condition or the implicit learning condition, as in the Pilot Study. Two key changes were made to the stereotype learning task for Study 1. First, the target pictures used in the Pilot study were replaced by pictures of an avatar created using computer software. The use of the avatar allowed for great control over the appearance of the target and reduced the possibility of pre-existing stereotypes as the avatar was intentionally created to look as neutral as possible. This made it less likely that the target would be categorized into additional groups or that participants would stereotype the target before learning about him in the trials. The avatar was male and was carefully posed in the same way for each set of cues. The pieces of clothing used were a pair of sunglasses, a hat, a jacket, and a sweater.
We also changed the group names in Study 1. Instead of using characteristics (Friendly vs. Unfriendly) as in the Pilot Study we simply used the titles of Group A and Group B. These labels were intended to remove any affective, judgment based characteristics from the task. Participants could not have preconceived attitudes or opinions about the groups or the names of the groups.

Following the learning trials, participants completed a series of 28 testing trials. In each trial, participants were presented with a target from the learning phase and indicated the group membership of the target. All 14 possible patterns of cues were presented in random order twice.

### 3.2.2.3 Depletion Manipulation

Following the learning phase and initial testing phase, participants engaged in an e-crossing task to manipulate levels of regulatory depletion. Participants in the control condition were instructed to cross off every instance of the letter “e” on two sheets of boring text. Participants in the depletion condition were given the same instructions but were also given a series of complex rules to make the task more difficult. Instead of crossing off every instance of the letter “e”, participants in this condition were told to cross the letter off only if it was not next to another vowel or separated from another vowel by only one consonant. The more complex instructions require more self-control and were expected to deplete the self-regulatory resource. Participants were stopped after seven minutes due to time constraints.

Following the e-crossing task, participants completed a second stereotype testing phase consisting of an additional 28 test trials.
3.2.2.4 Stereotype Strength Measurement.

Finally, participants were given the stereotype strength measurement task that assesses explicit knowledge of the indicators of group membership. Participants were shown a picture of the target with each set of fourteen cues and were asked to estimate the likelihood that the target belonged to a specific group, from 0% likely to 100% likely. This task was done twice, first asking the likelihood that each set of cues indicated membership to Group A, then asking whether each set of cues indicated membership in Group B.

3.3 Results and Discussion

Three participants were eliminated for failing to choose the higher number more than once during the learning phase of the explicit condition, indicating that they were not paying attention during the learning task. Eleven participants were eliminated from the implicit learning condition for failing to identify the correct number of high-pitched tones more than 25% of the time. Failure to count tones suggests that these participants were more focused on the stereotype learning task while expending little effort on the distracting tone counting task. Because the tone counting task was used to ensure that participants were learning implicitly, these particular participants may have formed both an explicit and an implicit stereotype of the target individual. There were no significant differences between males and females, thus gender was not used as a predictor in the analysis.

During the initial testing phase, the raw average score for the implicit learning condition was 59% correct and for the explicit learning condition it was 63% correct. An
initial manipulation check comparing the stereotype strength of participants in the explicit learning condition ($n = 66$) to those in the implicit learning condition ($n = 57$) for the first testing phase using a between subjects $t$-test revealed no differences between the two groups, $t(119) = 0.997, p = .419$. There was a marginally significant difference in the first testing phase between participants in the implicit learning condition who took the non-depleting version of the e-crossing task ($M = 55\%, n = 28$) and participants who took the depleting version ($M = 66\%, n = 29$), $t(53) = 1.868, p = .067$. Up to and including the first testing phase, the procedures for these two groups were identical. As the study took place on the computer without experimenter interaction, it seems unlikely that the difference was caused by experimenter bias.

Any differences in initial learning between the four conditions would make it difficult to accurately compare the effects of the depletion task between conditions. Several participants, particularly those in the control condition who had learned implicitly, scored poorly on the first testing phase. Without the required knowledge of the cues and stereotypes strong enough to make accurate predictions, we cannot determine whether there was any effect due to resource depletion. Thus, further analysis focuses on only participants with strong stereotypes, defined as having correctly grouped at least 55% of the targets in the testing phase. This resulted in the loss of 24 participants from the explicit learning condition and 23 from the implicit learning condition.

Participants in the depletion conditions saw their performance decrease 5% following the depletion task, whereas non-depleted participants improved 3% after
completing the control task, a statistically significant difference, $t(72) = 3.601, p = .001$. This result suggests that the depletion task did have an effect on stereotype strength, reducing the likelihood of depleted individuals using stereotypes compared with those in the control conditions. The e-crossing task has been used successfully in previous studies, but we did not test its effects using a separate task to avoid additional depletion to both conditions. Most tasks used to test for depletion have been used in other studies as the depletion manipulation, suggesting that engaging in the “manipulation check” could be as depleting as the manipulation itself. Testing the self-regulatory resources of both conditions may have depleted the control condition, reducing any difference between the groups.

Both the decrease in performance for the depletion condition and the increase in performance for the control condition were driven mostly by changes in the implicit learning conditions (see Table 1). It was hypothesized that depletion would have a profound negative impact on the ability of explicit learners to use their knowledge of stereotypes, but would have no effect or even a slightly positive effect on the ability to stereotype for implicit learners. Results showed that, contrary to expectations, explicit learners in the depletion condition saw a non-significant decrease in performance from the first testing phase to the second testing phase of 2%, $t(18) = -1.252, p = .227$. Furthermore, implicit learners in the depletion condition saw an unexpected significant 7% drop in performance, $t(20) = -3.208, p = .004$. 

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Table 1: Means and Standard Deviations for Study 1 Performance Metrics by Experimental Condition

<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>Explicit Learning</th>
<th>Implicit Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Depleted, n = 19</td>
<td>Depleted, n = 21</td>
</tr>
<tr>
<td>Testing Phase 1</td>
<td>76.10 (9.61)</td>
<td>72.82 (8.19)</td>
</tr>
<tr>
<td></td>
<td>(73.41 (10.08)</td>
<td>69.55 (7.49)</td>
</tr>
<tr>
<td>Testing Phase 2</td>
<td>73.25 (10.05)</td>
<td>73.61 (11.59)</td>
</tr>
<tr>
<td></td>
<td>66.67 (16.35)</td>
<td>76.60 (6.92)</td>
</tr>
<tr>
<td>Explicit Knowledge Task</td>
<td>1515.53 (202.86)</td>
<td>1461.05 (161.46)</td>
</tr>
<tr>
<td>Brief Self Control scale</td>
<td>43.84 (7.68)</td>
<td>42.81 (6.63)</td>
</tr>
</tbody>
</table>

Of the participants who were not depleted, those in the explicit learning condition saw a non-significant increase in the percentage of correct responses (1%), $t(20) = .364, p = .720$. Implicit learners in the control condition experienced an unexpected and significant increase of 7% from the first testing phase to the second testing phase, $t(12) = 3.69, p = .003$.

The relationship between depletion and stereotype learning seen in the data is contrary to hypotheses. The significant decrease in performance of depleted implicit learners without the corresponding drop in performance by depleted explicit learners is the most difficult to explain. The depletion task was expected to produce the same results as a distraction task, limiting cognitive abilities and forcing a reliance on automatic behavior. It is possible that explicit stereotypes do not require the attention or cognitive resources that would be limited by a depletion task. Rather than a set of complicated rules, each stereotype may have been a single fact to be remembered. If each pattern of cues produces a specific outcome, one must only remember what each
pattern means and recall it as necessary. Alternatively, participants may have focused on one or two cues which also would have made the stereotyping process less complex than balancing the probabilities of several cues. In the real world, cues that are perceived as important (race, gender) may be given precedence over more subtle cues (clothing, mannerisms) when deciding group membership.

The increase in performance for implicit learners in the control condition may also suggest unexpected characteristics of implicit stereotypes specifically but also implicit learning in general. One possibility is that implicit learning requires a “settling” period before the information can be accurately applied. In this case eight additional minutes saw an improvement of seven percent with no new information or feedback. Perhaps this implicit, procedural knowledge takes longer to process than declarative, explicit information. Although a fact can be repeated back immediately, it may take time to identify the steps that led to specific feedback and to choose future actions to minimize negative outcomes and maximize positive outcomes. It may explain the common advice to set a task aside and to return to it later, or the necessity of repeated practice when learning a complicated process.

Another possible explanation for the improved performance of participants in the control condition who learned implicitly is that they could have developed explicit stereotypes by remembering their choices in the first testing phase. Attitudes are often based on previous behaviors. In this case, stating that specific cues predict different outcomes may be enough to create explicit stereotypes. Why would someone say that a cue predicted group membership if they didn’t believe it? Participants in this study may
have remembered their previous judgments and used them as explicit knowledge to make future judgments.

Estimates from the explicit knowledge task were aggregated into an accuracy score for each participant by summing the absolute difference between the participants’ estimate for each target and the actual probability of group membership for that target. Participants in the implicit learning group ($M = 1356.79$) were more accurate than those in the explicit learning group when estimating group membership ($M = 1486.93$), $t(72) = -3.42, p = .001$. There was no difference between depleted participants ($M = 1447.53$) and non-depleted participants ($M = 1403.15$), $t(72) = 1.09, p = .278$. This is unexpected as stronger explicit knowledge of probabilities by those in the explicit learning conditions has been found in several previous Weather Prediction Task studies. These results do not seem to be driven by the depletion task, as the pattern of results is the same for both the depletion and control conditions.

The results of the explicit knowledge task do provide some support for the theory that participants in the implicit learning condition were learning explicit stereotypes by remembering their own responses in the first testing phase. These ratings took place following both the second testing phase and the depletion task. Implicit learners had time to think about their own responses on the first testing phase as well as the second testing phase, possibly considering the strength of each probability. If explicit learners had memorized which cues predicted which outcomes without considering the strength of the relationship, their knowledge may have been more useful for binary decisions when a Group A/Group B choice was all that was necessary. The
memorization techniques learned in the explicit learning paradigm may have been resistant to the depletion task. However, whatever form of explicit knowledge those in the implicit learning condition had, it was significantly less useful following the depletion task. Another consideration would be the time constraints of each task. The testing phases demanded quick responses, whereas the explicit knowledge task allowed participants to make careful estimates before giving their answers.

The responses from the thirteen questions from the Brief Control Scale were summed to create a composite score after eight questions were reverse-scored. Composite scores had a mean of 43.52 (SD = 7.01) and range of 24 to 56. Scores on the Brief Self-Control Scale were not significantly correlated with scores on the first testing phase, $r = -.07, p = .471$, or the second testing phase, $r = -.104, p = .251$. Correlations were not significant when looking at implicit and explicit learners separately.

The Brief Control Scale was tested as a possible moderator of the change in performance between the first testing phase and second testing phase for participants in the depletion condition. In a regression analysis predicting change in performance for depleted participants using Learning condition and the Brief Control Scale as main effects and the interaction between these two factors, the main effect of the Brief Control Scale, $B = 0.012, SE = 0.007, t = 1.746, p = .089$, and the interaction, $B = -0.008, SE = 0.004, t = -1.801, p = .08$, were marginally significant (see Figure 1). This suggests that higher levels of trait self-control as measured by the scale may have benefitted explicit learners while hurting the performance of implicit learners.
These results, along with the finding that depleted participants saw bigger decreases in performance than the non-depleted comparison groups, suggest that self-regulation does play some role in the stereotyping process. Just as distraction can inhibit stereotype usage in some situations (Gilbert and Hixon 1991), depletion inhibited some stereotypes, in this case those that were learned implicitly. Furthermore, the interaction between self-control and condition was marginally significant, suggesting that higher self-control was beneficial to those in the implicit learning condition but not the explicit learning condition.

Although many of the findings in this study ran counter to the hypothesized relationships between stereotype learning and self-regulatory depletion, there was evidence that the method of learning does create stereotypes with different characteristics. Implicit learners saw greater effects of resource depletion and had better explicit knowledge of the cue probabilities compared to explicit learners. Although the
effects were not expected, it is still possible that stereotype learning plays a role in the activation and application of real life stereotypes.
4. Study 2

4.1 Overview

In real life, people are often told to ignore cues such as race, gender, or age when categorizing another individual. Study 2 focuses on whether individuals can “subtract” the significance of a specific cue from their overall predictive judgment of group membership. By telling participants to avoid using a specific cue when categorizing a target because the cue is no longer predictive of group membership, we intend to study whether individuals can intentionally avoid using stereotypes.

Participants performed the same stereotype formation tasks as described in previous studies. However, prior to a final testing phase, we asked participants to ignore a particular cue. The ability to ignore the nullified cue was expected to vary between conditions. Participants in the explicit learning condition were expected to effectively ignore the nullified cue, categorizing the target based solely on the three remaining useful cues. Participants in the implicit learning condition were expected to have trouble avoiding the nullified cue when making their categorizations. These participants, who may not consciously understand the original significance of the nullified cue, are unlikely to know how to subtract the predictive value of the cue from their overall stereotype.
4.2 Method

4.2.1 Participants

One-hundred and five students (54 women) from the University of Northern Colorado participated in the study for partial research credit in their psychology course.

4.2.2 Procedure

Participants were randomly assigned to the implicit or explicit learning conditions as they entered the lab. Participants then learned to categorize targets based on clothing cues. Participants were taught these cues using their randomly assigned learning procedure, as described in the previous studies. Following the learning phase, participants completed an initial testing phase of 28 trials to assess whether learning had occurred and to establish a baseline of learning. After the first testing phase, participants were told that a change had occurred, and that both groups now wear one of the pieces of clothing at equal rates. Thus, that particular item of clothing was no longer a useful piece of information for determining group category and should be ignored. Participants then completed a second testing phase with the understanding that, with the new information, they should avoid using the nullified cue. The second testing phase was comprised of 28 additional trials. Participants then completed an explicit knowledge task as in Study 1 that asked them to use all of the cues.

4.3 Results and Discussion

As in Study 1, five participants were eliminated from the explicit learning condition for failing to choose the higher number more than once during the learning phase, suggesting that they were not paying careful attention to the learning task.
Seventeen participants were also eliminated from the implicit learning condition for not identifying the correct number of tones. Thus, the total number of participants used for the initial analysis was 83. There were no significant differences between males and females, thus gender was not used as a predictor in the analysis. There were no significant differences between males and females, thus gender was not used as a predictor in the analysis.

During the initial testing phase, the raw average score was 53% correct for the implicit learning condition ($n = 40$) and 67% correct for the explicit learning condition ($n = 43$). The mean score for participants in the implicit learning condition was considerably lower than the 60% correct observed in the pilot study using the same procedure. Participants in the implicit learning condition scored significantly worse than those in the explicit learning condition, $t(81) = 3.48, p = .001$.

The conspicuously poor performance of participants in the implicit learning condition during the first testing phase was unexpected and thus warranted further analysis. The responses participants gave during the learning phase were examined to determine whether they had failed to learn during the task or if there was an issue with the testing phase itself. Composite scores were created from all 100 learning trials and from the last 50 learning trials. Success rates for the last 50 trials were expected to be higher as participants had seen more trials and likely had a more developed sense of the relationship between cues and outcomes. Participants in the implicit learning condition scored 59% correct overall and 57% correct in the second half, both of which exceeded the testing scores for the implicit learning condition in the Pilot Study. These results
suggest that at least some participants were able to learn to use the cues, although they
did not seem to benefit from the last half of the learning trials.

As in Study 1, further analysis uses only those who scored 55% correct or above
in the first testing phase. This limited the sample size to 31 in the explicit learning
condition and 18 in the implicit learning condition. After applying these criteria, the
average percentage of correct categorizations within the first testing phase was 74% for
explicit learners and 73% for implicit learners (see Table 2).

Participants were asked to ignore only one of the cues during the second testing
phase. This cue was present in half of the 14 possible patterns and was one of the
strongest predictors, predicting membership to Group A 76% of the time when it
appeared in learning trials. We had hypothesized that the percentage of correct scores
would decrease more for participants in the implicit learning condition than in the
explicit learning condition when trying to inhibit one of the cues. Percentage of correct
scores dropped for both conditions in the second testing phase. In the declarative
condition, the percentage of correct responses decreased to 68%. In the implicit learning
condition, the percentage of correct responses decreased to 60%. Although participants
in the implicit learning condition demonstrated a larger drop-off in performance (13%)
compared with participants in the explicit learning condition (6%), this difference was
not statistically significant, $t(47) = 1.35, p = .183.$

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1 Performing this test with participants who had failed to reach 55% on the first testing
phase also did not indicate a significant difference in the change scores between the
explicit learning condition ($M = 4\%$) and the implicit learning condition ($M = 2\%$),
$t(81)=0.58, p = .562$. 

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<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Implicit Learning</th>
<th>Explicit Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>n</td>
</tr>
<tr>
<td>Testing Phase 1</td>
<td>72.67 (9.98)</td>
<td>18</td>
</tr>
<tr>
<td>Testing Phase 2</td>
<td>60.46 (18.70)</td>
<td>18</td>
</tr>
<tr>
<td>Testing Phase 1, Relevant Trials*</td>
<td>68.90 (10.64)</td>
<td>21</td>
</tr>
<tr>
<td>Testing Phase 2, Relevant Trials*</td>
<td>60.37 (23.25)</td>
<td>21</td>
</tr>
<tr>
<td>Testing Phase 2, Relevant Trials*, All Cues†</td>
<td>73.63 (23.75)</td>
<td>21</td>
</tr>
<tr>
<td>Explicit Knowledge Task</td>
<td>643.02 (197.81)</td>
<td>15</td>
</tr>
<tr>
<td>Brief Self Control Scale</td>
<td>41.89 (8.37)</td>
<td>18</td>
</tr>
</tbody>
</table>

*Relevant trials are trials that include the cue to be ignored.
†This analysis used all cues, including the cue to be ignored, to determine the correct response.

To test participants’ ability to ignore this specific cue, we recalculated the testing scores using only trials in which the target cue appeared. These relevant trials are the ones that should be affected by the change in cue probability. These calculations were done for both the first testing phase and the second testing phase. Instead of using the
55% correct threshold on all trials during the first testing phase, this analysis included any participants who scored 55% correct on the trials that included the target cue during the first testing phase. Thirty participants in the explicit learning condition and 21 participants in the implicit learning condition scored at least 55% correct on the key trials in the first testing phase. Participants in the explicit learning condition scored 75% correct on the first testing phase and 67% correct on the second testing phase, whereas participants in the implicit learning condition scored 69% correct on the first testing phase and 60% correct on the second testing phase. Change in performance from the first testing phase to the second testing phase was not significant between conditions, $t(49) = 0.06, p = .954$.

Despite the non-significant results, the data within this study trended in the hypothesized direction when looking at all of the trials, although the difference in performance change was not significant between conditions. When analyzing just the trials with the key cue, we found no apparent difference in the ability to inhibit that cue when making a group judgment. Both groups struggled equally with the inhibition instructions which highlights the difficulties associated with stereotype inhibition; the cue in this study was recently learned and relatively obvious but it still caused issues in a number of group categorizations.

The primary hypothesis of this study was that ignoring a cue would be particularly difficult for participants in the implicit learning condition. To test whether participants had in fact used the nullified cue on trials where they had been asked to ignore it, we tested how well participants would have performed if the cue probabilities
had remained the same between the first and second testing phases. As in the previous
analysis, only trials that included the target cue were used. Applying the same scoring
method as the first testing phase, participants in both the explicit learning condition and
implicit learning condition scored 74% correct on the second testing phase using these
parameters. The improvement in the implicit learning condition (5%) was not
significantly greater than the improvement in the explicit learning condition (1%), $t(49) = -0.755, p = .454$.

The explicit knowledge of the cues was calculated using the same method as
Study 1. Participants were told to use all of the cues, including the cue that they had
ignored in the second testing phase, when making their estimates. As in Study 1, and
counter to expectations, participants in the implicit learning condition were more
accurate ($M = 643.02$) than those in the explicit learning condition ($M = 747.230$), $t(43) = 2.13, p = .039^2$. The results replicate the findings from Study 1 even though participants in
Study 2 completed the explicit knowledge task without taking the e-crossing task first.
This suggests that it was not the additional time or effort from the e-crossing task that
led to differences in explicit knowledge. Instead, it is either the learning paradigms
themselves or the method for testing stereotype strength that are creating these
differences.

Correlational analyses suggested that explicit knowledge of the stereotype, as
measured using this score, was not correlated to actual testing phase performance for

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2 Participants completed half as many trials of this task in Study 2 as they had in Study 1. Participants were
only asked to estimate the probability of belonging to Group A. As a result, the means in this study are
lower than those in Study 1.
participants (first testing phase, $r = -.122, p = .424$, second testing phase, $r = -.032, p = .833$). Looking at each condition individually, there was no correlation for the explicit learning condition between explicit knowledge score and performance on the first testing phase, $r = -.225, p = .232$, or the second testing phase, $r = .098, p = .605$. The same was true for the implicit learning condition, as explicit knowledge scores were not correlated to percent correct on the first testing phase, $r = .029, p = .917$, or the second testing phase, $r = -.288, p = .298$. The lack of a correlation between explicit knowledge and success on the testing phase suggests that it was not the ability to accurately guess probabilities that led to success on the group categorization task. The binary choice (Group A/ Group B) of the stereotype testing task either requires different information or it requires using the same information in a different way.

Scores on the Brief Self Control scale were calculated as in Study 1. We had hypothesized that participants with higher self-control may have had more success when trying to ignore one of the cues because suppressing a stereotype requires self-regulation. The change in percent correct between testing phase 1 and testing phase 2 was tested using a regression analysis. Main effects of condition and Brief Self Control score were included as well as the interaction between the two factors. Neither the main effect of Brief Self Control score, $B = 0.010, SE = 0.006, t = 1.22, p = .228$, nor the interaction, $B = -0.006, SE = 0.006, t = -1.01, p = .316$, were significant. High trait self-control was a predictor of performance for depleted participants in Study 1 but not for participants attempting to suppress a stereotype in this analysis. It is possible that the
suppression of stereotypes in this study did not require the regulatory resources hypothesized, an explanation supported by the lack of a main effect for trait self-control.
5. General Discussion

The results of these studies indicate that people are able to learn stereotypes in a lab setting, either through an explicit learning paradigm or through an implicit learning paradigm. In both studies the learning of the desired stereotypes was observed only among some participants; some participants were able to learn stereotypes quite accurately, whereas other participants could not pick up on the relationship between the clothing cues and group membership after 100 learning trials. Because only participants who demonstrated knowledge of the stereotypes could be included in the analysis the attrition rates for both studies were far higher than those seen in the Weather Prediction literature and posed a threat the internal validity of the experiments.

One possible issue is that we were unable to take into account the individual differences between participants. Although gender and the Brief Self Control Scale did not predict cue learning, there may be other traits that allow some individuals to pick up patterns faster than others. In the future tests of pattern recognition or learning styles may reveal which participants learn the task faster or slower than others. A more immediate concern is that we do not know which participants were lost in this study. Are the reported results only valid for a small subset of the total population who can learn stereotypes easily?

The targets in Study 1 and Study 2 were purposefully designed so that nothing was different except for the clothing used as probabilistic cues. It is still possible that some participants learned different rules than those intended. Participants may have
focused on the combinations of clothing instead of the specific items. For example, they could have worked out that the hat mattered only if the sunglasses were also present. Another alternative is that they could have grouped items into categories, so that items worn on the head predicted one outcome while other pieces of clothing predicted the other outcome.

The Weather Prediction studies were able to get around this problem by offering relatively simple cues (shapes) and putting them in different orders to make it clear that the placement did not matter. If different interpretations of the cues are behind the learning difficulties, it would underscore the difficulties of this type of research, namely that human appearances and behavior can vary in thousands of ways, either subtle or extreme, and each person is likely to interpret those differences and similarities in different ways. Perhaps this is why research tends to focus on racism and sexism rather than characteristics that could be seen as individual differences.

Another possible issue with learning in these studies is that the attitudes, judgments, and motivations behind these stereotypes had been stripped away. The targets wore relatively common pieces of clothing and the group names were changed to the generic titles of Group A and Group B. The participants in the studies were never given a reason to learn the stereotypes and it was never made personally relevant to their lives. It may be that stereotype learning is more than simple pattern recognition and requires motivation for the stereotypes to be learned.

Another issue with the studies that led to participant attrition was the tone counting task in the implicit learning condition. Whereas some participants in the explicit
learning condition were left out of the analysis for failing to identify the higher number in a simple two-number choice, those participants were likely not paying enough attention to the learning task. For the tone-counting task, it is more difficult to determine what caused participants to fail when counting a small number of tones. Possibly these participants felt that the tone-counting task was unimportant and did not much in the necessary effort. Another possibility is that individual differences in the ability to perform more than one task at the same time meant that some participants lacked this skill and would be unable to learn implicitly no matter how many opportunities they were given.

The overall findings do suggest different characteristics of stereotype activation based on how the stereotypes were learned. In both studies, participants in the implicit learning conditions demonstrated better explicit knowledge of the cue probabilities. In Study 1, implicit learners exhibited different stereotype strength depending on whether they had been depleted or not when no such change was apparent in explicit learners. High scores on the Brief Self Control Scale also predicted better results for participants in the explicit learning condition but lower results for those in the implicit learning condition. In both studies, participants in the implicit learning condition exhibited better explicit knowledge of the probabilities. Although this result was one of several unexpected findings, the differences in performance after using different learning paradigms offers evidence to support more research into stereotype learning and the examination of the systems used to learn implicit and explicit stereotypes.
In particular, the finding that participants in the implicit learning condition were more accurate when estimating the probability of group membership than participants in the explicit learning condition is deserving of additional study. Similar studies on probabilistic learning using the Weather Prediction task have produced results which suggest that explicit learning creates more accurate explicit knowledge of cue probabilities. The results in the present research are consistent across studies but conflict with similar research, raising the possibility that learning about other people is somehow fundamentally different than learning about other outcomes. Performing identical studies using people and inanimate objects as the respective targets would be a direct method for determining whether the same processes hold true for stereotyping as they do for other types of probabilistic pattern recognition. People may be fundamentally more difficult to categorize due to the number of possible characteristics that could change and the multitude of meanings behind each characteristic in an increasingly multi-cultural and connected world.

Another possibility worthy of exploration is that implicit knowledge requires extra time before it becomes a reliable source of information. A study using the same learning paradigms but testing participants immediately, at five minutes, and at ten minutes would provide insight into this issue. Ideally, we would set up a study that both taught and tested stereotype learning over the course of several days, allowing for information processing each night before testing again the next day.

Although the present research was the result of years of careful planning, in hindsight there are changes to the procedure that would potentially result in more
reliable results. First, additional trials in each testing phase would reduce the importance of each response and give a more accurate measure of stereotype strength. Additional testing trials would potentially reduce some of the learning issues experienced in studies 1 and 2. Although 50 extra trials did not make a difference in the Pilot study, participants in the Pilot study also did better overall than participants in the later studies. Finally, in replicating these studies it would be useful to give participants the explicit knowledge task at different points in the study. If the testing phases do provide explicit knowledge through the memory of responses, asking for probability estimates first would resolve the conflicting results regarding explicit knowledge of the cues.

Although there is considerable work to be done before the methods described in this research can be fully implemented, the idea of creating implicit and explicit stereotypes in the lab still holds promise. Stereotype research would benefit from the opportunity to create custom stereotypes specifically tailored to the type of study and participants who will take part. Creating separate implicit and explicit stereotypes would open new possibilities for testing in the lab and would contribute to research on which systems and areas of the brain are responsible for different types of stereotype learning and use. Perhaps most importantly, determining how participants inhibit implicitly learned vs. explicitly learned stereotypes and what conditions lead to successful inhibition can have far reaching consequences in the areas of discrimination research. Creating stereotypes will be necessary to address these issues and although the present research fails to give a clear road map it does provide the foundation for future work in this area.
Appendices

Appendix 1 Data Tables for Study 1 Analysis

Table 3: Regression of Learning Condition and Brief Self Control scale score on change in Stereotyping Performance when asked to ignore one cue.

<table>
<thead>
<tr>
<th></th>
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<th>SE(B)</th>
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<tbody>
<tr>
<td>Constant</td>
<td>-.494*</td>
<td>.293</td>
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<tr>
<td>Condition</td>
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<td>.185</td>
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<tr>
<td>Brief Self Control</td>
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<tr>
<td>Condition x Brief Self Control Scale</td>
<td>-.008†</td>
<td>.004</td>
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* p < .05  
† p < .10
### Appendix 2 Data Tables for Study 2 Analysis

**Table 4**: Regression of Learning Condition and Brief Self Control scale score on change in Stereotyping Performance when asked to ignore one cue.

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<tbody>
<tr>
<td>Constant</td>
<td>-.365*</td>
<td>.348</td>
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<tr>
<td>Condition</td>
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<tr>
<td>Brief Self Control scale</td>
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<td>.008</td>
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<tr>
<td>Condition x Brief Self Control Scale</td>
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<td>.006</td>
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* $p < .05$
## Appendix 3 Group Membership Probability by Cue Presence

<table>
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<tr>
<th>Stimulus</th>
<th>Cue1</th>
<th>Cue2</th>
<th>Cue3</th>
<th>Cue4</th>
<th>Frequency</th>
<th>P(\text{Group 1})</th>
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<tr>
<td>1</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>9</td>
<td>.889</td>
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<td>x</td>
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<td>x</td>
<td>9</td>
<td>.111</td>
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Appendix 4 Items from the Brief Self Control Scale

1. I am good at resisting temptation.
2. (R) I have a hard time breaking bad habits.
3. (R) I am lazy.
4. (R) I say inappropriate things.
6. (R) I do certain things that are bad for me, if they are fun.
13. I refuse things that are bad for me.
17. (R) I wish I had more self-discipline.
22. People would say that I have iron self-discipline.
28. (R) Pleasure and fun sometimes keep me from getting work done.
29. (R) I have trouble concentrating.
30. I am able to work effectively toward long-term goals.
31. (R) Sometimes I can’t stop myself from doing something, even if I know it is wrong.
32. (R) I often act without thinking through all the alternatives.

Participants are asked to rate the degree to which each of the statements reflects how they typically are. All responses are given on a five point scale, with 1 representing “Not at all” and 5 representing “Very much”.

Appendix 5 Implicit Stereotype Learning Task Instructions

You will be learning to judge this man based on the clothes he is wearing:

Pieces of clothing can appear alone or in combination.

First, the man will be presented on the screen and you will guess to which group he belongs. When you see each picture, press the key marked "1" if you believe that he a member of Group A. Press the key marked "2" if you think that he is a member of Group B.

You will see a large number of pictures. Your task is to make a prediction within 3 seconds or the computer will move on automatically.

After you make a guess, the computer will present the correct answer. Based on this feedback, you will learn what pieces of clothing indicate membership in Group A or Group B.

While you are practicing, we want you to keep track of audio tones you will hear after each trial.

Each time the correct group appears on the screen, you will hear a low pitched or high pitched tone.

After five trials, the computer will ask you how many high pitched tones you heard. If you hear 3 high pitched and 2 low pitched tones, you will press the number, 3. It is very important that you keep track of the tones.

So, you have two tasks. One is to guess the man’s group membership and the other is to count tones.
Appendix 6 Explicit Stereotype Learning Task Instructions

You will be learning to predict this man's group membership based on the clothes he is wearing:

Pieces of clothing can appear alone or in combination.

First, the man will be presented on the screen along with his group membership (Group A or Group B). When you see each new picture of the man, please press the space bar on the keyboard.

You will see a large number of pictures. Your task is to consciously remember what the pieces of clothing predict about his group membership. Some pieces of clothing indicate that he belongs to Group A and others that he belongs to Group B, and your job is to learn which is which. Only the pieces of clothing decide his group membership.

The computer will show each picture for 3 seconds before moving on automatically.
Appendix 7 Explicit Knowledge Task Instructions

Now you will be shown several combinations of clothing. Please estimate the probability that the person on the screen belongs to Group A based on the clothes that they are wearing. For example, if you believe that there is a 70% chance that they belong to Group A, type 70 into the space provided. Please use all pieces of clothing, including jackets, when estimating. If you have any questions, ask the experimenter now before you start.
Appendix 8 Screen Shot of Learning Trials

Group A
Appendix 9 Screen Shot of Testing Trials

1
Group A

2
Group B
References


*Neuroscience and Behavioral Reviews, 32*: 237-248.


*Behavioral Neuroscience, 118*, no. 2: 438-442.


Anthony Michael Pascoe was born in Sarasota, Florida, on May 29, 1982, to Frank and Mary Pascoe. Anthony received his B.A. in Psychology and English from the University of Massachusetts, Amherst in Amherst, MA, in 2004, and his M.A. in Social Psychology from Duke University in Durham, NC, in May of 2008. He currently lives in Colorado with his wife Libby and their dog Oscar.
