LANGUAGE SUPPORTS PERCEPTUAL SYMBOLS FOR EMOTION

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# ABSTRACT

Cameron M. Doyle: Language supports perceptual symbols for emotion
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The present studies test the hypothesis that language shapes emotion perception by reactivating sensorimotor aspects of prior experiences to shape the perception of others' facial actions. In Study 1, I show that language guides the acquisition of new exemplars of emotional facial actions ("perceptual symbols") that then bias subsequent perceptions of similar emotional facial actions. In a learning phase, participants viewed non-stereotypical instances of *anger* and *fear,* and categorized them using the words "anger" and "fear" (verbal condition) or made a perceptual judgment that did not require emotion words (control condition). Next, in a target phase, participants studied slightly different facial actions and categorized them using the words previously linked with the learned perceptual symbols. Finally, during a test phase, participants identified which face the individual had been making during the target phase (i.e., the learned face, the target face, or a morphed combination). As predicted, participants were more likely to choose the face that had been linked with a word during the learning phase than the face actually studied in the target phase, suggesting that perceptual symbols acquired during prior experiences can bias later perceptions of emotion. Study 2 replicated and extended Study 1 to show that even nonsense labels can guide the acquisition of perceptual symbols for never-before-seen facial actions. These findings demonstrate that language is doing the "heavy-lifting" during emotion perception by helping participants first acquire perceptual symbols for emotion, and then

access them during subsequent perceptions to make meaning of facial actions as instances of emotion. Implications for emotion theory and applications to special populations are discussed.

## TABLE OF CONTENTS

## LIST OF FIGURES

# CHAPTER 1: THEORETICAL BACKGROUND

Imagine someone who looks angry. Chances are, you just imagined the last angry person you saw by envisioning the particular scowl, frown, grimace, or growl made by your coworker, spouse, friend, or favorite television villain. But how did you know that person was angry when you saw him or her making those facial actions in the first place? Most likely it appeared to you that anger was just *there,* present on his face for the world to see. Yet growing evidence suggests that the ability to perceive a discrete emotion ("anger," "disgust," "fear," etc.) in someone else's facial actions is a constructive process that relies on your pre-existing knowledge about emotional facial actions (Lindquist, MacCormack, & Shablack, 2015, Lindquist, Satpute & Gendron, 2015, Lindquist, Gendron, & Satpute, 2016). The scowls, frowns, grimaces, and growls you saw in the past are part of your conceptual knowledge of "anger" and help you make meaning of new instances of facial actions. So the next time you see a friend as angry, you will likely be drawing on conceptual knowledge acquired during prior instances of seeing others as angry to make meaning of your friend's facial actions.

The idea that emotion perception relies on knowledge acquired via prior experience is consistent with a psychological constructionist approach to emotion. According to this view, a person perceives an instance of emotion on someone else's face when he or she detects facial muscle movements signifying pleasure, displeasure, activation, or deactivation, and then makes meaning of those movements using knowledge about specific emotion categories (e.g., "anger" v. "disgust," v. "fear," v. "sadness") (Barrett, Lindquist & Gendron, 2007; Barrett, Mesquita & Gendron, 2011; Lindquist & Gendron, 2013; Lindquist, Satpute & Gendron, 2015). For instance, all human faces move in ways that signify pleasure, displeasure, startle and social aggression, yet different cultures make meaning of those basic actions in different ways (Jack, Sun, Delis, Garrod, & Schyns, 2016). The process of meaning making is generally called "categorization" in psychology at large, but simulationist accounts of categorization refer to this process as "situated conceptualization" (Barsalou, 2009; Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011) to denote the fact that all categorizations draw on context-specific knowledge. In the case of emotion, the emotion words a person knows refer to a cache of modality-specific knowledge about emotions acquired across specific instances. The various scowls, frowns, grimaces and growls that were perceived in the past when seeing angry individuals across myriad different contexts (e.g., anger at an employee, anger at a child, anger at a malfunctioning computer) are stored as "perceptual symbols" of sensorimotor aspects of prior experience that are reactivated during subsequent perceptions (Barsalou, 1999).

Growing evidence suggests that conceptual knowledge about emotion categories (e.g., anger) is important to the perception of emotion in faces (e.g., Aviezer et al. 2008a; Aviezer et al. 2008b; Aviezer, Trope, & Todorov, 2012; Hassin, Aviezer, & Bentin, 2013; Gendron et al. 2012; Nook et al. 2015; Lindquist et al. 2006; 2014; Widen & Russell, 2010; Noh & Isaacowitz, 2013; Ngo & Isaacowitz, 2015; for reviews see Lindquist & Gendron, 2013; Lindquist, Gendron & Satpute, 2016; Lindquist, MacCormack & Shablack, 2015; Lindquist, Satpute, & Gendron, 2015). Yet no studies to date have examined the ultimate mechanisms by which conceptual knowledge supported by language might shape the perception of emotion from facial actions.

I begin by reviewing evidence in support of the role of language in the acquisition of conceptual knowledge about emotion categories. Next, I propose a hypothesis for the mechanism by which language may play role in emotion—that is, that emotion words reactivate sensorimotor representations of prior experiences that were previously paired with those words, which contributes to how incoming sensory information from faces is perceived (Barrett et al., 2007). Finally, I present findings from two studies that provide support for this hypothesis by demonstrating that language helps individuals to acquire and then use conceptual knowledge about emotions to make meaning of others' facial actions.

**Language guides category acquisition**

Language is important to the acquisition of concept knowledge about all manner of categories. For instance, the phonological form of words has been shown to help infants acquire category knowledge about objects (e.g., Dewar & Xu, 2009; Ferry, Hespos, & Waxman, 2010; Gliga, Volein, & Csibra, 2010), perhaps because words are "essence placeholders" (cf. Xu, 2002) that activate the most diagnostic features of a category for use during categorizations (see Lupyan & Thompson-Schill, 2012; Waxman & Gelman, 2009). Labeling perceptually distinct objects with the same word also enables infants to infer that, despite perceptual differences, those objects belong to the same category (Plunkett et al. 2008, see Waxman & Gelman, 2009).

In much the same way, words help adults acquire novel perceptual categories (e.g., Fugate et al. 2010; Lupyan, Rakison, & McClelland, 2007; Lupyan & Cassanto, 2015). For instance, labels helped perceivers learn to categorize individuals from a never-before-seen fictional "alien" species as those that should be either approached or avoided (Lupyan et al., 2007). Participants who learned nonsense labels to describe meaningful perceptual features of members of the alien species outperformed those who did not learn labels, even when the labels were not themselves necessary to engage in the categorization task (Lupyan et al., 2007). That is, words appeared on the screen during the categorization task for participants in the verbal condition, but were not necessary to the categorization task itself. I predict that words play a similar role in emotion, helping to group together certain perceptual features (e.g., a scowl, furrowed brows) as members of a certain perceptual category in some instances (e.g., “anger”), but members of a different perceptual category (e.g., “fear”) in other instances.

Words may be especially critical in developing categories for emotion because category-specific statistical regularities in the sensory information available on a face (e.g., facial muscle actions) are low due to the inherent variability within emotion categories (Barrett, 2006; Cacioppo et al. 2000; Mauss & Robinson, 2009; Siegel et al. under review). For instance, objective measurements of facial muscle movements using electromyography cannot reveal a single pattern of facial muscle movements that exists for the category of anger (Cacioppo et al. 2000). Furthermore, not all people make the same facial expression when experiencing anger (if they make a facial expression at all; see Reisenzein et al. 2013) and the facial expressions made and perceived differ by context and culture (e.g., Gendron, Roberson, van der Vyver, & Barrett, 2014; Jack et al. 2016; for reviews see Barrett et al. 2011; Elfenbein, 2013; Fernandez-Dols & Crivelli, 2013; Hassin et al. 2013; Nelson & Russell, 2013). Language might thus be a form of “glue” that holds together visual representations of perceptually distinct facial actions as members of the same emotion category.

**Language shapes emotion perception**

Consistent with the evidence that language guides the acquisition of concept knowledge about emotion categories, language plays an important, albeit covert, role in emotion perception (for reviews, see Barrett, Lindquist & Gendron, 2007; Barrett, Mesquita, & Gendron, 2011; Lindquist & Gendron, 2013; Lindquist, Satpute & Gendron, 2015). For example, in a sequential priming paradigm, individuals are faster and more sensitive to match a face (e.g., a scowling face) to a word naming an emotion concept (e.g., “anger”) than to another face (e.g., another scowling face) (Nook, Lindquist & Zaki, 2015). This is likely because words prompt more categorical perceptions of visual stimuli than other cues (Edmiston & Lupyan, 2015; Lupyan & Thompson-Schill, 2012). These findings suggest that the presence of language during emotion perception helps us to make meaning of other peoples' facial actions as instances of discrete emotion.

There is also evidence that the absence of emotion concept knowledge during tasks hinders emotion perception. For example, temporarily reducing access to an emotion concept word (e.g., "anger") impairs the perception of emotional facial actions (e.g., a scowling face), even when the task itself does not require labeling (e.g., as in perceptual priming; Gendron, Lindquist, Barsalou & Barrett, 2012; or perceptual matching; Lindquist, Barrett, Bliss-Moreau & Russell, 2006; Roberson & Davidoff, 2000). Similarly, individuals who have permanently impaired concept knowledge due to a neurodegenerative disease called semantic dementia demonstrate impaired perception of emotional facial actions, although they maintain the ability to perceive the general affective valence (positivity v. negativity v. neutrality) of those actions (Lindquist, Gendron, Barrett & Dickerson, 2014). These findings are consistent with the idea that emotion words help individuals to categorize very general information about faces (e.g., the valence of a facial expression) into instances of specific discrete emotion categories (e.g., anger v. fear v. disgust v. sadness). Even healthy individuals fail to perceive emotional facial actions in terms of discrete emotion categories (i.e., display categorical perception) when emotion concept words are not part of the experimental task (see Lindquist & Gendron, 2013 for a review).

**A proposed mechanism for the role of language in emotion perception**

Although growing evidence suggests that language is integral to emotion perception, no studies to date have specifically investigated the ultimate mechanism by which language shapes the perception of emotion from facial actions. It is possible that emotion words play a role in emotion perception by helping to activate the concept knowledge about emotion categories that is integral to perceiving emotion in others' facial muscle movements (Barrett, Lindquist & Gendron, 2007; Fugate, 2013; Lindquist & Gendron, 2013; Lindquist, Gendron & Satpute, 2016; Lindquist, Satpute, & Gendron, 2015; see Medin & Smith, 1984 for a review of the role of concepts in categorization). This concept knowledge helps to reduce the uncertainty that is inherent in most naturally occurring pleasant or unpleasant facial actions, resolving these actions into perceptions of discrete behaviors associated with discrete emotion categories such as *anger*, *fear*, or *sadness* (for reviews, see Barrett, et al. 2007; Barrett, et al. 2011; Gendron, Mesquita, & Barrett, 2013; Lindquist & Gendron, 2013; Lindquist, Satpute & Gendron, 2015). Consistent with this view, labeling faces with emotion words helps to reduce amygdala activation in response to those faces (Lieberman et al. 2007; see Brooks et al. in press for a meta-analysis); the amygdala is a brain region that is responsive to novelty and uncertainty (see Cunningham & Brosch, 2012; Whalen, 1998; Weierich, Wright, Negreira, Dickerson & Barrett, 2010). In effect, concept knowledge about emotion categories is hypothesized to reduce the perceiver's uncertainty about the meaning of pleasant or unpleasant facial actions.

The idea that language helps to disambiguate information from facial actions is consistent with predictive coding (Clark, 2013; Lupyan & Clark, 2015; Friston, 2010; Hohwy, 2013) and simulationist (Barsalou, 2009; Martin, 2016; Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011) accounts of cognition, which suggest that "top down" conceptual knowledge from prior experiences is used to make predictions about and shape the perception of incoming "bottom-up" sensory information. Simulationist accounts in particular argue that this conceptual knowledge is made up of modality-specific information (e.g., visual, auditory, etc.) acquired across prior sensory experiences, and that this information is reactivated during new perceptions to help make meaning of incoming "bottom-up" sensations from the world (Barsalou, 2009; Martin, 2016; Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011). According to such simulationist accounts, semantic knowledge is not exclusively represented as abstract propositional knowledge about a category (e.g., "anger involves scowling"), but as perceptual symbols (Barsalou, 1999) constructed out of prior modality-specific experiences of that category (e.g., a partial re-enactment of a previous visual experience of a scowling face) (Kan, Barsalou, Solomon, Minor, & Thompson-Schill, 2003; Pecher, Zeelenberg, & Barsalou, 2004; Gallese & Lakoff, 2005). Neurons in the modalities (e.g., vision, audition, interoception, motor behavior) capture sensory and motor elements of a perceptual event, and neural representations accumulate to produce a "simulator" that serves as a toolbox for creating any future conceptual representation of a category (see Barsalou, 1999; Barrett & Lindquist, 2008). Thus, prior instances of visual perceptions are thought to help shape future perceptions in a "top-down" manner when they are paired with words. If this is the case, then the mechanism by which language shapes emotion perception may be similar to the way that concept knowledge shapes any visual perception (i.e., through the activation of perceptual symbols; Barsalou, 1999). A novel, and yet unexplored hypothesis is that the activation of concept knowledge of emotion supported by language shapes how visual sensations are perceived in the first place. For example, activation of language during a perceptual experience might allow a perceiver to see another person's mouth as scowling v. frowning. This idea is consistent with the "perceptual inference hypothesis," which was originally set forth by Barrett et al. (2007).

Perceptual Inference Hypothesis

A viable hypothesis for the role of language in emotion perception is that emotion words reactivate sensorimotor representations that were previously paired with those words, which contributes to how incoming sensory information from faces is actually seen in the first place. Consistent with the idea that language can shape the perception of incoming sensory information, language has been shown to facilitate the detection of otherwise invisible objects in the visual field (Lupyan & Ward, 2013). The objects were camouflaged from participants' view using continuous flash suppression (CFS), a technique in which a static visual stimulus is presented to one eye, and a series of rapidly changing stimuli are simultaneously presented to the other eye (Tsuchiya & Koch, 2005). This procedure engenders inter-ocular competition that renders the static stimulus "invisible." Using CFS, Lupyan and Ward (2013) demonstrate that simply hearing a word (e.g., "pumpkin") denoting the suppressed stimulus (e.g., an image of a pumpkin) is enough to "boost" the visual representation of that stimulus into awareness, enabling participants to see what would otherwise not have been selected into visual awareness. This finding suggests that the presence of language brings online conceptual knowledge about object categories, making information about those categories more salient during visual perception.

In the case of emotion perception, emotion words may serve as a sort of prime to help individuals pick up on emotionally relevant information presented on a face. The conceptual knowledge that individuals have about emotion categories undoubtedly plays a role in how faces are perceived and analyzed. For instance, Halberstadt and Niedenthal (2001) provide evidence that the way emotional faces are conceptualized during visual perception can actually shift perceptual memories of those faces. Specifically, they show that conceptualizing morphed happiness-anger faces as depicting *anger* leads participants to remember the faces as angrier (e.g., closer to anger on the happiness-anger continuum) than they actually were. The findings from this and other studies of categorical perception of faces (for a review, see Fugate, 2013) demonstrate that the concept knowledge we have about particular emotion categories can help us make meaning of emotional faces. The ease with which we perceive emotion on faces paired with the tremendous variability in the facial actions associated with a single emotion category implies that we routinely use conceptual information to make meaning of others' emotions in our daily lives. For example, the word "anger" might cohere together an individual's embodied knowledge about the causes and consequences of the emotion concept *anger*, as well as stored representations of what others' angry facial "expressions" have looked like across different contexts in the past. The word "anger" thus allows an individual to store representations of various facial actions as instances of the same category.

It is possible that repeatedly pairing instances of the emotion *anger* with the label "anger" over time (as is done in daily life when we categorize our own and others' emotions) leads to the formation of specific perceptual symbols (Barsalou, 1999) for the category *anger.* These perceptual symbols might shape the subsequent processing of other faces as instances of *anger* through a feedback loop. For instance, concept knowledge of *anger* that is activated by a given situation (e.g., getting cut off in traffic) might reactivate the word "anger" (and, by extension, the sensorimotor representation of an angry face that has been previously paired with the word "anger") in the mind of a perceiver. Sensorimotor reactivation of prior experiences with perceiving angry faces might lead perceivers to literally see the perceptual information in the present environment as more consistent with the emotion category anger. In the perceptual inference hypothesis, words are thought to help perceivers to first acquire perceptual symbols for specific emotion categories, update those perceptual symbols to reflect new situation-specific perceptual information, and then later bring those perceptual symbols online to aid in visual perception of new instances of emotional facial actions. The present studies specifically test this hypothesis.

## CHAPTER 2: THE PRESENT STUDIES

Study 1 uses a learning paradigm adapted from Santos (2008) to investigate whether words guide the acquisition of perceptual symbols for emotion that shape perception of subsequently presented faces paired with the same words. This learning paradigm enabled me to test the perceptual inference hypothesis which predicts that language helps participants to first acquire new perceptual symbols for emotion categories, and then use those perceptual symbols to make meaning of subsequent instances of emotional facial actions. In a learning phase of the experiment, participants viewed non-stereotypical instances of anger and fear paired with the words “anger” and “fear” (the verbal condition) or made a perceptual judgment of the features of the faces (control condition). Perceivers were next presented with a series of faces that exhibited slightly different, more stereotypical instances of anger and fear than those presented during the learning phase (the target phase of the experiment). Finally, a test phase assessed the extent to which perceptions of the target faces was biased by the perceptual symbols acquired during the learning phase. Evidence of bias would suggest that perceptual symbols for emotion are acquired when facial actions are paired with words and that these perceptual symbols can shift perceptions of subsequently viewed faces.

Study 2 replicates and extends the findings of Study 1 by demonstrating that learning to associate novel facial actions with nonsense emotion words (vs. making another perceptual judgment about faces) enhanced bias in perceptual memory of novel “emotion categories.” This finding suggests that words play a particularly important role in the acquisition and use of perceptual symbols for emotion categories. Participants had no prior experience with the novel facial actions and nonsense words, and yet they exhibited the biased effect seen in Study 1.

## CHAPTER 3: STUDY 1

Study 1 tested the importance of emotion words in emotion perception by demonstrating that learning to pair facial actions with emotion words biases the perception of subsequently viewed faces toward the learned category information. Participants were randomly assigned to one of two between-subjects conditions. In the *verbal condition*, participants were asked to categorize pictures of eight digital identities depicting non-stereotyped emotional facial actions as instances of “fear” v. “anger.” Alternatively, in the *control condition,* participants were asked to make a perceptual judgment about the features of the non-stereotyped emotional facial actions by judging how close together vs. far apart the eyes of the face were (as per Gendron et al. 2012). This perceptual judgment was chosen because it encouraged participants to view the central features of faces that are diagnostic for rendering emotion judgments (Adolphs, Gosselin, Buchanan, Tranel, Schyns, & Damasio, 2005), but did not explicitly invoke emotion category words. Because there was no clear “accuracy” criterion for this perceptual judgment, I could not compute accuracy rates for the control condition. However, accuracy rates for the emotion judgments in the verbal condition were high ($M$ = 98.23%, $SD$ = 4.69). Following the learning phase, participants completed a target phase in which they categorized stereotypical emotional facial actions as instances of “fear” vs. “anger,” as well as a buffer phase and test phase. I predicted that if emotion words were important in acquiring and then activating perceptual symbols that bias participants’ perceptual memory for subsequently seen facial actions, then participants in the verbal condition would show higher bias scores than those in the control condition.

**Method**

**Participants.** Participants were 91 undergraduate students (44 women, $M_{age} = 19.30$, $SD = 2.82$). Data from eight participants were removed because they failed to complete at least 75% of the trials in either the learning or target phase. Data from two additional participants were removed because they failed to enter a response on two trials in the test phase. Because missing two or more responses meant that I had 75% or less of these participants' test phase data, I chose to exclude these two participants as well (final $N = 81$).

**Procedure and Data Analysis.** Participants were positioned approximately 20 inches from a monitor with a screen resolution of 1440 x 900 pixels. The images presented were 250 x 310 pixels. Thus, the images subtended approximately 7.9° x 10.8° of visual angle.

*Learning phase*. As Figure 1 illustrates, participants completed 128 trials where they viewed non-stereotypical depictions of *fear* and *anger* and were asked to categorize the faces as "fear" vs. "anger" (*verbal condition*) or "close" vs. "far" (*control condition*). Non-stereotypical actions are not typically associated with *fear* and *anger* (e.g., fearful faces were frowning with slightly raised eyebrows or angry faces were open-mouthed and scowling with slightly raised eyebrows). On each trial, the face was one of eight digital identities created in the Poser 7 3D character art and animation software (http://poser.smithmicro.com/poser.html). Poser allowed me to manipulate the specific facial actions displayed on faces and create both stereotypical and non-stereotyped exemplars for each category. Two identities were used to create perceptual categories for *fear*, and two for *anger* (which identity displayed which category was counter-balanced across participants). Participants categorized the face as "anger" or "fear" via a button press and repeated the answer out loud (to ensure they were engaging in the task). Participants received feedback on whether their response was accurate or inaccurate. Each identity was presented a total of 16 times, each time shown with the same stereotyped emotional facial action for one of the two emotions used in the study (i.e., *fear* and *anger*). Mean accuracy was high ($M$ = 99.50%, $SD$ = 0.91), indicating that participants were attending to the task and were easily able to categorize the faces when forced-choice labels were provided. Following a 1-minute break, participants completed the target phase.

*Target phase*. As Figure 1 illustrates, participants viewed the same eight identities from the learning phase, but this time the faces depicted stereotypical facial actions. Stereotypical faces were developed based on the caricatures of English emotional facial actions depicted in Ekman & Friesen (1976). For instance, fearful faces had wide eyes, raised eyebrows and open mouths. Angry faces had furrowed eyebrows and clenched teeth. See Figure 1 for examples of caricatured, stereotypical facial behaviors associated with English emotion categories. Participants were told that their goal in this phase was to learn the names of the individuals they had seen previously. In reality, the purpose of this phase was to expose perceivers to the target faces while activating the perceptual symbols established for the two emotion words during the learning phase. My interest was to see if those perceptual symbols would then bias perception and encoding of the target faces. To ensure that participants did not explicitly encode differences between the learned and target faces, target facial actions were only subtly different from the faces seen during the learning phase. On each trial, a stereotyped face appeared for 3s along with a name (i.e., “Brian,” “John,” “Matt,” “Steve”), and participants were asked to learn the individual’s name. Following the name presentation, participants were also asked to categorize the face as “anger” or “fear” as they had done in the learning phase. Categorizing the new faces using emotion labels was intended to further activate the perceptual symbols that had been associated previously with each word. Each identity was seen once; participants thus completed a total of eight trials.

*Buffer phase*. Participants performed a buffer task for 10 minutes, in which they completed a series of paper-and-pencil mazes. The buffer phase was included to ensure that perceptual symbols were not merely stored in working memory between the phases, or that my findings were merely evidence of perceptual priming.

*Test phase.* I assessed participants' perceptual memory for the target phase face by asking them to identify which face they studied when they learned the individual's name during the second phase of the experiment. On each trial, participants first saw one of the eight identities with a neutral face to cue them to the identity in question. Next, depictions of three emotional facial actions were displayed below it: the target face, the original learned face, and a 50%-50% morph of the two faces. Participants ranked the exemplars based on their confidence that each facial action was seen during the target phase. Participants pressed the number below each face to rank them in order (e.g., "1" for the learned face, "2" for the morphed face, or "3" for the target face). Faces were randomized such that on a given trial the target face could be in any one of the three positions. After 3s the screen refreshed, and participants were asked to select the face they were the *next* most confident they saw during the target phase (i.e., their "second choice"). I deduced participants' "third choice" based on their first and second choices. There was one test trial for each identity, for a total of eight trials. See Figure 1 for an overview of Study 1.

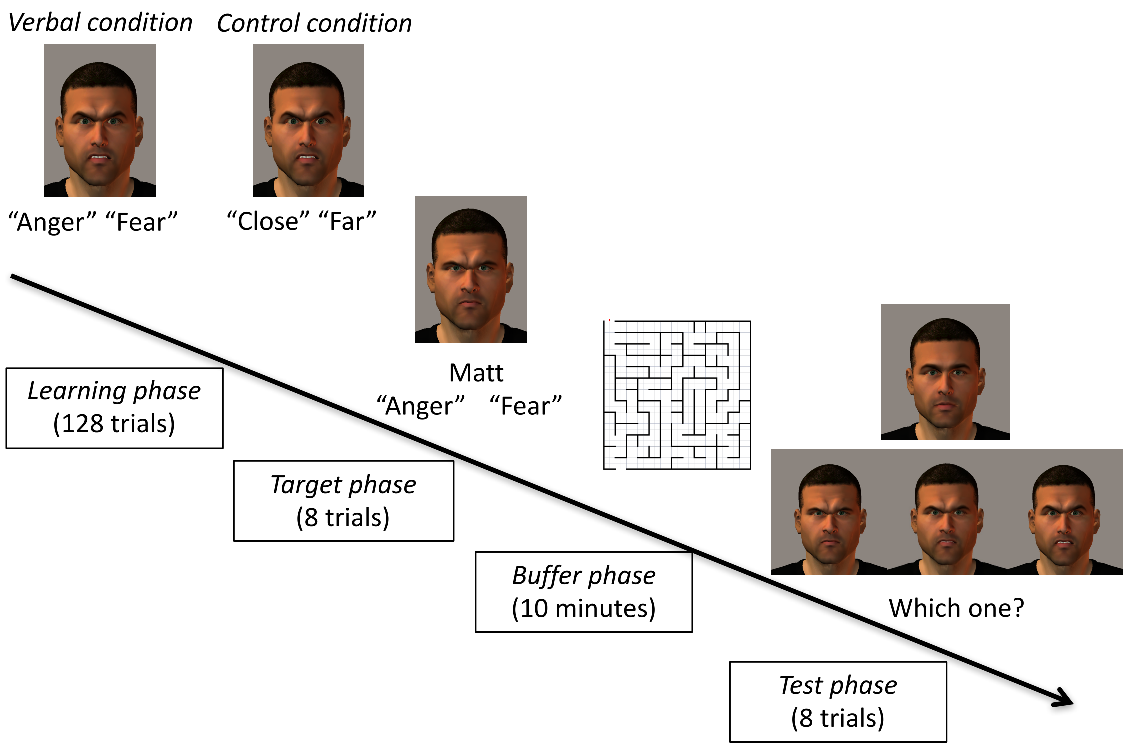


**Figure 1.** Overview of Study 1. Participants in the verbal condition learned to associate "non-stereotypical" facial expressions with emotion words. Participants in the control condition made a perceptual judgment about the features of the faces. Participants in both conditions then saw more stereotypical versions of the same emotion category during the target phase. In a buffer phase, participants completed a series of paper-and-pencil mazes. During the test phase, they were asked to rank order which facial expression they recalled seeing during the target phase: the learned face, the target face, or a morph of the two. I used a weighted "bias score" to see if participants' perceptual memory was biased towards the learned face.

*Data analysis.* My data analysis method was adapted from Santos (2008) to assess the extent to which a perceptual symbol of the learned face influenced the perception and encoding of the target face. I computed a *bias score* by assigning a weighted value to participants' responses for each trial in the test phase. The learned face was assigned a weight of 2, the target face was assigned a weight of 0, and the morphed face was assigned a weight of 1 (because it was a 50-50% blend of the two). Weights were then multiplied by participants' responses. For instance, if a participant ranked the learned face "1", and the morph face "2" and the target face "3", then the contrast would be (2 x 2) + (1 x 1) + (0 x 0) = 5, indicating the largest degree of bias. If a participant ranked the target face "1", and the morph face "2" and the learned face "3", the contrast would be (0 x 2) + (1 x 1) + (2 x 0) = 1, indicating no bias. This bias score was computed for participants' responses on each of the eight test trials, and the mean bias score was calculated for each participant across trials. Mean bias scores were compared to two different values in a one-sample t-test. First, I compared mean bias scores to the value of 1, which indicated that there was no bias in the weighted contrast (i.e., participants consistently chose the target face first, followed by the morph, followed by the learned face). Second, I compared mean bias scores to the value of 3, since 3 represented the mid-point of the 1-5 bias range.

Since it can be argued that participants' first choice is an indication of their most confident perceptual memory, I also computed descriptive analyses by indicating on which percentage of trials participants chose the learned face first, the morph face first, and the target face first. This provided a complementary index of participants' memory for the faces presented in the target phase.

**Results**

As predicted, emotion words were relatively more likely to help participants form perceptual symbols for emotion that then biased perceptions of subsequently perceived faces. Mean bias values for the test trials were significantly greater than 1 for both the verbal ($M$ = 3.78, $SD$ = .81), $t(41) = 22.19$ $p < .001$, $d = 3.42$, 95% CI [2.53, 3.04] and control ($M$=3.39 $SD$=.63) conditions $t(38) = 23.74$, $p < .001$, $d = 3.80$, 95% CI [2.18, 2.59]. Mean bias values were also greater than 3 for verbal, $t(41) = 6.24$ $p < .001$, $d = 0.96$, 95% CI [0.53, 1.04] and control $t(38)=3.83$, $p < .001$, $d = 0.62$, 95% CI [0.18, 0.59] conditions.[1] Most importantly, as predicted, bias values for the verbal condition were significantly greater than bias values for the control condition $t(79) = 2.45$, $p = .02$, $d = 0.55$, 95% CI [0.07, 0.72] (Figure 3), suggesting that emotion words preferentially helped to facilitate the acquisition of perceptual symbols for emotion categories and the extent to which newly acquired perceptual symbols influenced perceptions of subsequently perceived emotional facial actions.

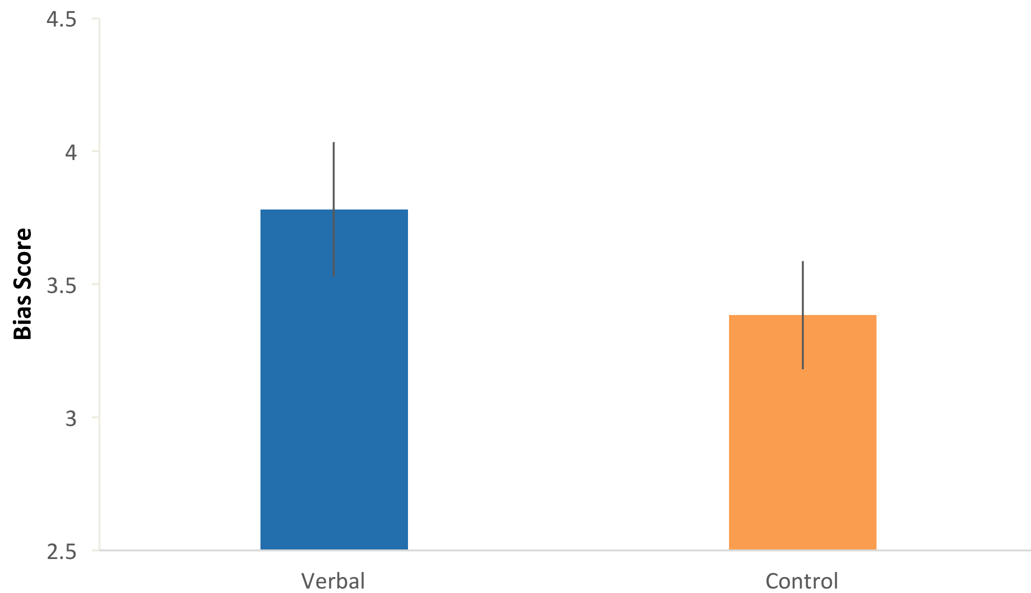


**Figure 2.** Bias scores from Study 1. Means and 95% confidence intervals reveal that verbal trials had significantly more bias than control trials, indicating that emotion words employed during the initial learning phase helped participants acquire new perceptual symbols that biased perception of subsequent faces towards the perceptual information presented in the learning phase.

[1]Results remained significant after correcting for two comparisons per condition using Bonferroni adjusted alpha levels of .025 per test.

As a follow-up to the bias score analysis, I investigated descriptively which face participants were more likely to choose first during the test phase.[2] Consistent with my hypotheses, participants in the verbal condition were marginally more likely than those in the control condition to choose the learned face first, $t(80) = 1.81$, $p = .075$, $d = 0.40$, 95% CI [-0.86%, 17.73%]. Consistent with the finding that words helped participants acquire novel perceptual symbols for emotion (i.e., representations of the specific faces presented), participants in the verbal condition were more likely to choose the learned face (on 50.00% of trials) first when deciding which face they had seen during the target phase, as compared to the actual target face (17.56% of trials), $t(41) = 5.29$, $p < .001$, $d = 1.48$, 95% CI [20.06%, 44.82%]. Participants were more likely to choose the morph face first (29.46% of trials) compared to the target face, $t(41) = 2.64$, $p = .01$, $d = 0.65$, 95% CI [2.80%, 21.01%]. Participants were also more likely to choose the learned face compared to the morph face first $t(41) = 3.74$, $p = .001$, $d = 0.99$, 95% CI [9.46%, 31.61%].

In the control condition, participants were again more likely to choose the learned face (on 41.56% of trials) first when deciding which face they had seen during the target phase, as compared to the actual target face (23.44% of trials), $t(39) = 3.83$, $p < .001$, $d = 0.69$, 95% CI [8.55%, 27.70%]. Participants in the control condition were also more likely to choose the morph face (33.13% of trials) compared to the target face first, $t(39) = 2.10$, $p = .042$, $d = 0.21$, 95% CI [0.35%, 19.03%]. Whereas participants in the verbal condition were more likely to choose the

[2] I again considered Bonferroni adjusted alpha levels of .017 because I conducted three tests per condition (i.e., .05/3). All three of the hypothesis tests for the verbal condition remained significant after considering this more conservative threshold.

learned vs. morph face first, participants in the control condition were equally likely to choose the learned vs. morph face first ($p > .05$).

**Discussion**

The findings from Study 1 suggest that pairing facial actions with emotion words in the verbal condition better facilitated the updating of perceptual symbols for emotion categories, which influenced perceptual memory for those faces. Without pairing the facial actions with emotion words, participants in the control condition were equally biased to choose the learned and morph faces first. These findings are all the more striking in that the updated perceptual information biased participants' perceptions away from the more stereotypical instances of emotion viewed in the target phase. Perceptual symbols for non-stereotypical facial actions of emotion were acquired when paired with words and biased perception of later facial actions. This effect likely reflects the reality of day-to-day life, since facial actions are not likely to match stereotypes of emotional facial expressions in varied day-to-day interactions.

The findings of Study 1 are the first demonstration that perceptual symbols for emotion categories, like artifact categories (e.g., images of computerized devices; Santos, 2008), can be updated in the course of a single experimental session. This work demonstrated that perceptual symbols biased later perceptual memory for other facial actions. These findings show that language is doing the heavy lifting by guiding the updating of perceptual symbols of emotion that bias later perceptions of emotion on faces.

## CHAPTER 4: STUDY 2

Study 1 explicitly tested the importance of language in helping participants acquire perceptual symbols for known emotion categories (anger and fear). Presumably, the English-speaking participants in Study 1 already understood the meaning of the emotion labels “anger” and “fear” prior to the start of the experiment, and possessed pre-existing perceptual symbols for those particular emotion categories. Associating the words “anger” and “fear” with ostensibly angry and fearful faces enabled participants to update their perceptual symbols for the emotion categories anger and fear, with the result that their perceptions for new exemplars of anger and fear were shifted towards their newly updated perceptual symbols.

According to my hypotheses, it should in principle also be possible to create entirely new perceptual categories from facial actions that are not typically associated with emotion (e.g., chewing, yawning, blinking and so on) by pairing them with words. Indeed, there is some evidence to suggest that this is the case. Adults who learned to associate never-before-seen Chimpanzee facial actions (e.g., “bared teeth,” “hoot,” “scream,” and “play” expressions) with nonsense labels during an initial learning phase later showed categorical perception for those faces (i.e., perceived categorical boundaries in a series of morphed faces; e.g., hoot-scream morph). Participants who did not associate facial actions with labels did not show categorical perception (Fugate, et al. 2010; for a discussion of categorical perception, see Fugate, 2013). These findings suggest that words might be doing the “heavy-lifting” during emotion perception, helping participants to first acquire perceptual symbols for specific emotion categories, updating those perceptual symbols to reflect new situation-specific perceptual information, and then later bringing those perceptual symbols online to aid in later instances of emotion perception. Study 2 thus sought to replicate and extend the findings from Study 1 by testing whether language supports the formation of novel perceptual categories for never-before-seen "alien emotions."

**Method**

**Participants.** Participants were 111 undergraduate students (63 women, $M_{age}$ = 19.16, *SD* = 1.81). Data from seven participants were removed because their learning phase data were not properly saved, so I could not verify that they had completed at least 75% of the trials. Data from an additional 10 participants were removed because they failed to enter a response on at least two trials in the test phase, meaning that they responded to less than 75% of trials (final $N$ = 94). Importantly, results were identical whether these 17 participants were included in the final sample or not. I thus excluded them to be conservative as I did in Study 1.

**Stimuli.** Drawing inspiration from Lupyan, et al. (2007), I created a set of novel "alien" facial stimuli using the Poser Pro 2012 3D character art and animation software (http://poser.smithmicro.com/poser.html), which enabled me to manipulate the facial muscles of "alien" faces to create novel facial muscle configurations. In order to further decouple the stimuli from perceivers' existing emotion concept knowledge, I elongated the faces, colored them in shades of green and yellow, and told participants that they were members of a "fictional alien species." The stimuli were pilot tested on Amazon Mechanical Turk to ensure that perceivers did not consistently rate the faces as depicting human emotion categories (e.g., *anger*, *fear*). Pilot testing revealed that the stimuli used in the Study 1 (hereafter "Emotion 1" and "Emotion 2"; see Figure 3 for examples) were not freely labeled as depicting an instance of any single human emotion category with consistent frequency (i.e., although participants were able to label the stimuli with all manner of words, there was not consistent agreement amongst raters in terms of which emotion category words were freely produced). For instance, Emotion 1 was labeled as an instance of 18 different emotional and mental states ($N = 160$) (e.g., 18.75% of participants used labels such as “surprised” or “shocked,” 15.63% used labels such as “curious” or “interested,” 11.88% labeled it as “happiness,” “laughter,” “amusement,” “excitement,” or “joy,” 11.25% used labels such as “confused,” “befuddled,” or “dumbfounded,” and so on). Emotion 2 was labeled as 19 different emotional and mental states ($N = 166$) (e.g., 34.34% of participants used labels such as “happiness,” “laughter,” “amusement,” “excitement,” or “joy,” 21.08% used labels such as “surprised,” “appalled,” or “shocked,” 10.24% used labels such as “anger,” “fury,” or “mad and so on). The stimuli were ambiguous in terms of their emotional meaning and can thus be considered novel facial actions not clearly associated with specific English-language emotion categories.

Furthermore, the stimuli were not consistently rated as depicting either positive or negative valence. I asked participants to rate, on separate scales, the degree of positivity and negativity depicted on the faces. Participants had the option to decline to answer if they were unable to determine whether the faces depicted positivity or negativity. Paired samples t-tests revealed no differences in the degree to which participants perceived positivity vs. negativity on the faces, $t(173) = 1.498$, $p = .14$ (Emotion 1), and $t(149) = .521$, $p = .60$ (Emotion 2).

Emotion 1 Emotion 2

**Figure 3.** Examples of novel emotion stimuli used in Study 2. Stimuli were created using the Poser Pro 2012 3D art and animation software and were not reliably rated as depicting any single English-language emotion category.

**Procedure and Data Analysis.** Participants were positioned approximately 20 inches from a monitor with a screen resolution of 1440 x 900 pixels. The images presented were 275 x 297 pixels. Thus, the images subtended approximately 8.7° x 10.4° of visual angle.

I made three major changes to the procedure for Study 2. First, in the *verbal condition*, participants learned to categorize pictures of eight identities expressing two “novel emotion” categories using the nonsense labels “blurp” and “gep,”[3] whereas in the *control condition,* participants were asked to make an unrelated categorical perceptual judgment about the novel faces, judging whether the alien’s skin was more yellow or green in color. In contrast to Study 1

[3]Because certain nonsense consonant-vowel structures are typically associated with particular perceptual characteristics (Lupyan & Cassanto, 2015), the nonsense labels were counterbalanced such that some participants learned that “Emotion 1” was called “blurp” and others learned that it was called “gep” (and vice versa with “Emotion 2”).

(where participants judged how close vs. far apart the eyes were), this judgment was categorical in nature and had an accuracy criterion, which allowed me to ensure that participants were not more accurate in one of the learning conditions compared to the other. Accuracy rates for the categorical judgments in both the control condition (*M* = 98.96%, *SD* = 1.41) and verbal condition were high (*M* = 96.04%, *SD* = 10.41).

Second, the nature of the novel emotion categories necessitated the use of a modified procedure for the target phase of the experiment. Given that there are not stereotypes for the novel alien facial actions, I had to make the facial actions in the target phase appear different from those in the learning phase using a different method in Study 2. I used Poser to reduce the degree of activation in each facial action in the novel "emotions" by 20-50%, depending on the degree of activation of that particular facial action in the initial face. This achieved the goal of creating two exemplars that looked different from one another (e.g., if "Emotion 1" had lowered eyelids and a dropped jaw, the version seen in the target phase had 20% less lowered eyelids and 50% less lowered jaw).

Finally, because control participants had not yet been exposed to the nonsense emotion labels, they were simply exposed to the nonsense labels after they learned the aliens' names in the target phase. Being exposed to the nonsense labels is an appropriate control task because the purpose of this phase is simply to bring the "emotion word" online in the presence of a slightly different "emotional" face. In the case of the participants in the verbal condition, this provided the opportunity to reactivate the novel perceptual symbols that participants had acquired previously and associated with the word. In the case of the control participants, there were no perceptual symbols associated with this "emotion word" but they were nonetheless exposed to the labels to control for the fact that verbal condition participants also saw the labels in the study phase. Otherwise, the procedure used in Study 2 was the same as that of Study 1. See Figure 4 for an overview of Study 2.

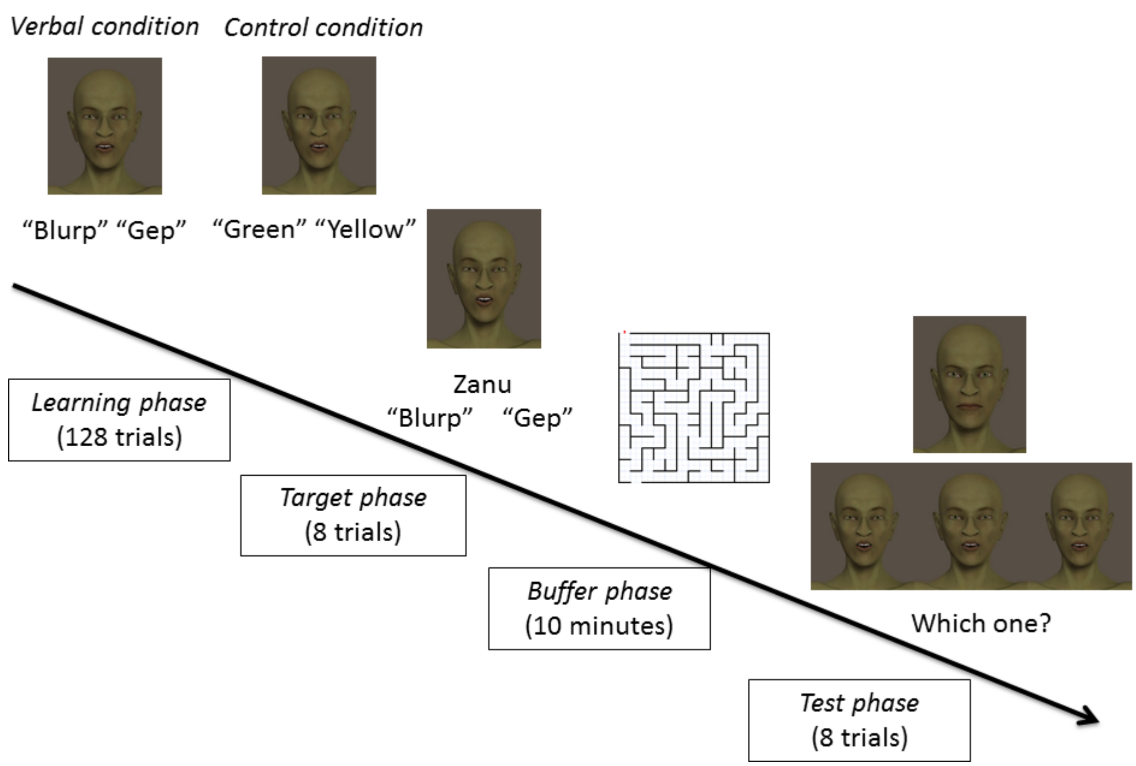


**Figure 4.** Overview of Study 2. Participants completed learning, target and test phases similar to Study 1. However, in Study 2, participants in the verbal condition learned to associate never-before-seen facial actions with nonsense labels. Participants in the control condition made a perceptual judgment about the color of the aliens' skin. In the target phase, participants saw slightly different instances of the never-before-seen facial actions and categorized them using the newly learned nonsense labels (verbal condition) or were simply exposed to the nonsense labels for the first time (control condition).

**Results**

Consistent with my predictions, the nonsense labels specifically helped participants form perceptual symbols for novel emotion categories and biased subsequent perceptions of the novel alien faces. As in Study 1, mean bias scores for the test trials were significantly greater than 1 for both the verbal condition ($M$ = 2.99, $SD$ = .64), $t(48) = 21.56$, $p < .001$, $d$ = 6.22, 95% CI [1.80, 2.17], and the control condition ($M$ = 2.61, $SD$ = .67), $t(44) = 16.16$, $p < .001$, $d$ = 4.87, 95% CI [1.41, 1.82], indicating some degree of bias. Mean bias values were not significantly different from 3 for the verbal condition ($p > .1$), but they were significantly less than 3 for the control condition, $t(44) = -3.86$, $p = .001$, $d$ = -1.16, 95% CI [-0.59, -0.18],[4] indicating a difference in the magnitude of bias between conditions. Most critical to my hypothesis, as in Study 1, bias values for the verbal condition were significantly larger than bias values for the control condition $t(92) = 2.73$, $p = .01$, $d$ = 0.56, 95% CI [0.10, 0.64] (Figure 7), suggesting that emotion words preferentially helped to facilitate the acquisition of novel perceptual symbols for emotion that biased perceptions of subsequently viewed faces.

[4]After correcting for two comparisons per condition using Bonferroni adjusted alpha levels of .025 per test, my results for the tests against the values of 1 and 3 for the control condition and the test against the value of 1 for the verbal condition remained significant.

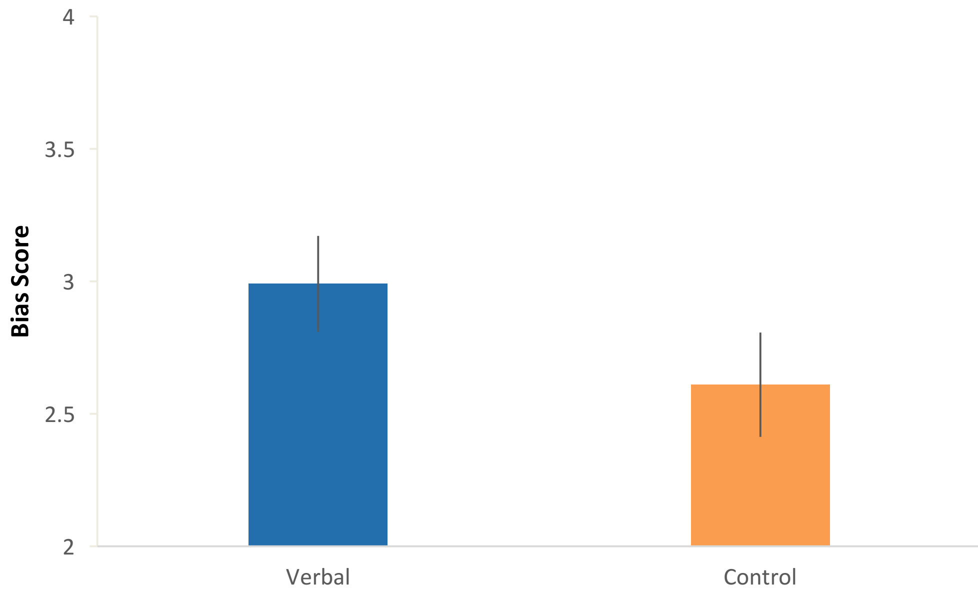


**Figure 5.** Bias scores from Study 2. Means and 95% confidence intervals reveal that, as in Study 1, verbal trials had significantly more bias than control trials. These findings suggest that nonsense words used as emotion labels in the learning phase helped participants acquire novel perceptual categories that biased perception of subsequent faces.

Also consistent with my hypothesis, participants in the verbal condition were significantly more likely than those in the control condition to choose the learned face first ($t(92) = 2.25$, $p = .03$, $d = 0.46$, 95% CI [1.00%, 15.93%]).[5] However, in contrast to Study 1, participants in the verbal condition were equally likely to choose the morph face (on 27.04% of trials) or target face (on 36.48% of trials) first when deciding which face they had seen during the target phase, as compared to the learned face (on 32.91% of trials) (*p*s > .10). Participants in the verbal condition were significantly more likely to choose the target face versus the morph face first ($t(48) = -2.65$, $p = .01$, $d = 0.61$, 95% CI [-16.60%, -2.28%]).[6] It is possible that participants in the verbal condition only chose the morph face first on 27% of trials because they

[5]This test is not significant at the Bonferroni adjusted threshold of .017.

[6]This test remains significant at the Bonferroni adjusted threshold of .017.

had not previously seen the morph face or paired it with a nonsense word during the learning or target phases. Thus, they had not acquired a perceptual symbol for that particular face, and so did not select it first on many of the trials in the test phase.

Consistent with the finding that words helped participants acquire completely novel perceptual symbols for emotion that biased later perceptions of exemplars from that category, participants who did *not* pair novel faces with words (control condition) were more likely to accurately choose the target face (on 42.78% of trials) first when deciding which face they had seen during the target phase, as compared to the learned face (24.44% of trials), $t(44) = -3.39$, $p = .001$, $d = 0.91$, 95% CI [-29.24%, -7.42%], or the morph face (28.89% of trials), $t(44) = -2.68$, $p = .01$, $d = 0.71$, 95% CI [-24.35%, -3.44%][7]. Participants in the control condition were equally likely to choose the learned vs. morph face first ($p > .10$). Thus, participants who did not pair novel "alien" facial actions with words during an initial learning phase more accurately perceived subsequently seen "alien" facial actions than did those who had initially learned to pair "alien" facial actions with words.

**Discussion**

Study 2 demonstrated that language guides the acquisition of novel perceptual symbols for never-before-seen facial actions. Pairing facial actions with nonsense words biased perceptions of other faces towards those new perceptual symbols. Bias due to newly learned perceptual symbols occurred even though the faces learned were completely novel and differed only subtly from the faces studied in the target phase.

These findings are similar to several previous findings observed in the literature. First, Roberson et al. (2007) found that labels biased perceptual memory towards the central tendency

[7]These tests remain significant at the Bonferroni adjusted threshold of .017.

of a category (i.e., the prototype) and away from the veridical perceptual symbol of that category. The learning phase of the present study may thus have served to create the prototype (i.e., most frequently observed) representation of the alien facial action. When individuals later saw and labeled a novel version of the alien facial action, it was encoded in memory as being more similar to the prototype acquired during the learning phase than the veridical representation seen during the target phase. Participants in the control condition, who did not pair facial actions with words during the learning phase, might have been less likely to acquire the prototype and thus less likely to show biased perceptual memory later at test.

Second, Halberstadt and Niedenthal (2001) found that individuals who paired a morph of angry and happy facial actions with the label "angry" later remembered the face as being more similar to a caricature of an angry facial expression than it actually was. Participants first viewed the morphed face, and labeled it as an instance of "anger." Next, participants viewed a continuous array of stimuli, ranging from 100% happiness to 100% anger. When asked to select the previously viewed face from the continuum, participants who had labeled the face as "anger" were more likely to choose a face that was closer to anger on the continuum than the morphed face actually was. In the present studies, individuals who did not pair faces with labels had relatively unbiased perceptual memory for the faces later. A similar mechanism is likely to underlie both my effects and Halberstadt and Niedenthal's effects, insofar as language is helping to support the perceptual symbols for emotion that are initially acquired and then used during subsequent instances of perception and perceptual memory.

As compared to Study 1, the bias effect in Study 2 was less robust. Participants were *relatively* more biased towards their newly acquired perceptual symbol in the verbal v. control condition, but participants' bias scores in the verbal condition were not significantly greater than the mid-point of the bias scale. These findings suggest a degree of bias, but participants were not as biased as they were in previous studies. This finding may be a result of the novel perceptual category participants were learning. Whereas participants were adding perceptual symbols to existing categories (*anger, fear*) in Study 1, in Study 2, participants acquired entirely new perceptual categories that did not in and of themselves have much meaning to the participants. One possibility is that with greater time and more pairings, participants would have developed a more robust perceptual category for the novel emotions. Another possibility is that asking participants to elaborate more on the emotions being experienced by the alien and inferring that those emotions had some purpose would have strengthened the effect. For instance, Halberstadt and Niedenthal (2001) observed the greatest bias in perceptual memory when participants were asked to really elaborate on *why* the morphed face observed was “angry.” Thus, it would be interesting in future studies to observe whether the bias effect becomes stronger when the words are associated with situated meaning during the learning phase (i.e., “gep” is an emotional facial action that the alien makes when it is communicating that it wants to go in search of food).

# CHAPTER 6: GENERAL DISCUSSION

Two studies demonstrated the role of language in the acquisition of conceptual knowledge about emotion categories. Study 1 demonstrated that words help individuals update existing perceptual symbols for the English emotion categories of *anger* and *fear*. Study 2 demonstrated that words help individuals acquire entirely novel perceptual symbols, as might occur when children are learning about emotions (i.e., Widen & Russell, 2003; 2010) or when individuals are learning the facial actions associated with emotion words in different cultures. Thus, Study 2 extended my findings to demonstrate that language guides the acquisition of novel perceptual symbols for never-before-seen facial actions.

In both studies, bias due to newly learned perceptual symbols occurred even when the faces learned were only subtly different from the faces studied in the target phase. It is important to note that because the acquisition of perceptual symbols can occur relatively quickly (e.g., within an experimental session), they are likely to change over time based on statistical regularities present in the environment.

These are the first studies to demonstrate that language reactivates conceptual information from prior experiences to shape sensory information from facial actions into perceptions of discrete emotions. However, the idea that conceptual knowledge shapes visual perceptions is not new. In fact, a century and a half ago, Helmholtz (1867/1925) noted that our prior experiences combine with momentary sensations to influence our ongoing perceptions of the world around us. The present research adds to growing evidence in support of Helmholtz's intuition.

**Implications**

My findings have several important theoretical and practical implications. First, they are consistent with psychological constructionist accounts of emotion, which hypothesize that language plays an important role in the perception and experience of emotion (Barrett et al. 2007; Lindquist et al. 2015; 2016; Lindquist, MacCormack & Shablack, 2015; Lindquist & Gendron, 2013). In particular, it is proposed that language plays a role in the acquisition and use of emotion category knowledge to guide perceptions of otherwise ambiguous facial muscle movements (cf. Lindquist, MacCormack & Shablack 2015). Psychological constructionist views challenge the long held assumption that the perceptual information contained in a person's face is enough for another person to perceive that he is angry, sad, afraid, etc. (e.g., Allport, 1924; Ekman, 1972; Tomkins, 1963). According to this "natural kinds" approach, emotion perception occurs in the blink of an eye because *anger*, *sadness*, and *fear* are perceptual categories that are language-free and are either inborn (Izard, 1971) or develop from the perceptual similarity of the expressions within a category (Allport, 1924; Ekman, 1999). An emerging body of evidence suggests, however, that emotion perception is achieved when prior instances of emotion perception and knowledge about emotion categories are brought to bear by the activation of emotion words (see Lindquist, MacCormack & Shablack, 2015; Lindquist, Satpute, & Gendron, 2015; Lindquist, Gendron, & Satpute, 2016 for reviews). Through this rapid, unconscious process, an individual is able to quickly disambiguate (and thereby make meaning of) another person's facial muscle movements.

Perhaps more practically, my findings have implications for psychological science because they suggest that the words embedded in perceptual tasks can shape what participants perceive. At the moment of perception, perceivers see emotional facial actions as members of a particular emotion category based on their most common, most recent, or most relevant perceptual symbol for that category. Once acquired, perceptual symbols for *anger* shape perceptions of subsequent faces that are labeled "anger" in a predictive manner. If words shape the formation and use of perceptual symbols, as in Study 1, then researchers can unintentionally introduce perceptual symbols in the minds of their participants any time stimuli are paired with words and repeated in an experiment (as in most forced-choice categorization studies). This could shape how stimuli on subsequent trials are remembered, categorized, or even perceived in the first place. For instance, Sauter et al. (2010) claimed to observe universality in the perception of emotional vocalizations because both Western participants and participants from the nomadic Himba tribe in Namibia could associate vocalizations with English emotion categories. In this study, participants completed a task that has historically been used in cross-cultural investigations of emotion (e.g., Ekman & Friesen, 1969): they heard a story about an individual experiencing an emotion and then they picked which of three emotional stimuli (in this case, emotional vocalizations) matched the story. However, in 2015, Sauter et al. published additional methodological details describing the fact that experimenters regularly performed "manipulation checks" prior to completing the study by asking Himba participants to listen to the story and to describe in their own words what individuals in the story were feeling. Researchers then performed a "rigorous manipulation check *with experimenter verification*" rather than relying solely on "participants' reports" of what was occurring in the story. That is, the experimenter corrected participants' if their perception was not in line with the Western emotion category intended by the experimenter. In this way, the researchers could have been influencing, and in fact, causing the participants to acquire emotion categories that were consistent with English emotion categories.

A broader implication of this work is that it can be applied in at least three special populations that would benefit from learning how to better perceive the emotions of those around them: Children, individuals with communication disorders, and immigrants in the process of acculturating to a new cultural context. First, understanding the role of language in the acquisition of emotion concepts could help us teach children how to more accurately perceive others' affective states as they are learning the words that are used to denote different emotion categories. This is implicitly recognized in the RULER approach to emotional intelligence applied in schools (Rivers & Brackett, 2010; Brackett et al. 2011). In this method, children learn to associate their personal experiences with new emotional language (e.g., regret) in an effort to help them recognize such feelings in themselves and others.

Second, this research suggests that the language and emotion deficits observed in individuals with autism spectrum disorder (ASD) may be caused by the same mechanism. This knowledge contributes to a better understanding of why individuals with ASD have trouble communicating with and relating to others.

Third, this research could help explain findings that recent immigrants who better understand the emotional patterns of their new culture report increased levels of relational well-being (De Leersnyder, Mesquita, Kim, Eom, & Choi, 2014). Although some basic facial actions associated with valence, arousal and aggression appear to be universal, there are multiple variations on these facial actions that are culture-specific (Jack et al. 2016). Training with words could help individuals who are new to a culture to better understand the conceptual knowledge about emotion categories that are prevalent in their daily lives, which could help them to better understand others' emotions.

## Limitations and Future Directions

There are limitations of the present studies that should be addressed in future research. The present findings cannot pinpoint whether the acquisition of perceptual symbols impacted the encoding of the faces seen during the target phase, the retrieval of those faces during the test phase, or both. Prior research suggests that both mechanisms are possible. For instance, there is growing evidence that emotion perception is an inherently context-dependent phenomenon (see Barrett et al. 2007; Barrett, Mesquita & Gendron, 2011; Fernandez-Dols & Crivelli, 2013; Hassin et al. 2013; Lindquist & Gendron, 2013; Lindquist, et al. 2015; Lindquist et al. 2016; Parkinson, 2013). The prior experience of the perceiver (cf., Barrett, et al. 2011) and the emotion word available to make meaning of a face (e.g., Barrett et al. 2007) served as context for emotion perception. Contextual influences on emotion perception are also consistent with evidence showing that context is intrinsically involved in even the most basic aspects of object perception (e.g., Bar et al. 2006).

Future research should examine at which points during perception/encoding and retrieval language is most specifically having an impact. Halberstadt (2005) has shown that language may be influencing emotion perception during encoding, and broader research on the role of concept knowledge in categorization may also be informative. Although there is some evidence to suggest that concept knowledge influences categorization during category learning, other evidence suggests that concept knowledge is activated during the category judgment (i.e., during perception) (for a discussion, see Murphy, 2002). It is further possible that the role of language in emotion perception is task-dependent. For instance, it may be that perceptual symbols supported by language are most likely to have an impact on perceptual processes when a person's goal is to detect categorical information from perceptual stimuli. In that case, language might have more or less of an impact on perception in some contexts and more or less of an impact on memory in others.

**Conclusion**

In conclusion, two studies demonstrated that emotion words support the acquisition of new exemplars of emotional facial actions (i.e., “perceptual symbols”). These perceptual symbols then biased subsequent perceptions of similar emotional facial actions. These findings add to growing evidence that language plays a role in emotion perception (Barrett et al. 2007; Herbert, Sfärlea, & Blumenthal, 2013; Lindquist, MacCormack & Shablack, 2015; Lindquist, Satpute, & Gendron, 2015; Lindquist, Gendron, & Satpute, in press; Lindquist & Gendron, 2013), perhaps because words help individuals to acquire and then use the perceptual symbols linked to a category to make meaning of facial actions as instances of emotion. Words—and the concepts they name—may help people form a template for making predictions about what facial actions mean in a given context (Lindquist et al. 2015).

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