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Face and Feeling: An Examination of the Role of Facial Feedback in Emotion

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To the Graduate Council:

I am submitting herewith a dissertation written by Nicholas Alvaro Coles entitled "Face and Feeling: An Examination of the Role of Facial Feedback in Emotion." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Psychology.

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Face and Feeling: An Examination of the Role of Facial Feedback in Emotion

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"Light the lamp and fire mellow

Cabin essence timely hello

Welcomes the time for a change"

\- B. Wilson and V. Parks

Dedicated to ambitious SMiLErs

Acknowledgments

The biggest problems in psychology require many minds. The work in this dissertation is the product of many minds, including my colleagues on the Many Smiles Collaboration and my dissertation committee members, Drs. Jeff Larsen, Lowell Gaertner, Michael Olson, and Dana Berkowitz. This work would not be possible without the support of my wife, Jessica, my dog, Coco (also known as Dr. CESI), my family, and my friends. This work was financially supported by funding from the National Science Foundation Graduate Research Fellowship and Graduate Research Opportunities Worldwide (both Grant No. 1452154). This work was also financially supported by Dr. Brad Stastny, who generously donated funds for this research in memory of his father, Bill Stastny.

This writing and defense of this dissertation was completed amidst the COVID-19 global pandemic, during which I felt compelled to redirect my attention to the Psychological Science Accelerator COVID-19 Research Task Force. There is much more I would like to say about the role of facial feedback in emotion, but I will temporarily shelve some of these ideas while I direct my attention towards the battle against COVID-19.

Abstract

The facial feedback hypothesis suggests that an individual's experience of emotion is influenced by their facial expressions. Researchers, however, currently face conflicting narratives about whether this hypothesis is valid. A large replication effort consistently failed to replicate a seminal demonstration of the facial feedback hypothesis, but meta-analysis suggests the effect is real. To address these conflicting narratives, the Many Smiles Collaboration was formed. In the Many Smiles Collaboration, a large team of researchers—some advocates of the facial feedback hypothesis, some critics, and some without strong belief—collaborated to specify the best ways to test this hypothesis. Two pilot tests suggested that smiling could both initiate feelings of happiness in otherwise non-emotional contexts and magnify ongoing feelings of happiness. A conceptual replication revealed that scowling could initiate feelings of anger but did not provide evidence that scowling could magnify ongoing feeling of anger. An integrative framework for studying facial feedback effects—the Facial Feedback Component Process Framework—is reviewed.

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Chapter 1: Introduction

Thousands of times in our lifetimes, we encounter the simple question, “How are you doing?” Assuming we are motivated to respond truthfully, we can answer this question almost effortlessly. “I’m happy that my paper was published.” “I’m grumpy.” “I’m relieved because Nick’s dissertation requires precisely zero revisions.” We experience and report on our emotional feelings so often and so effortlessly that we forget to take a moment to marvel at just how incredible this ability is. It is difficult, if not impossible, to imagine understanding our human condition without considering emotional feeling. Without it, there would be no pain or pleasure, no suffering or bliss, and no tragedy or glory in the human condition (Damasio, 1994). But what *is* emotional feeling and how does it work?

Early in the history of psychology, William James (1884, 1890, 1894) posited that emotional feeling is wholly based on signals from the peripheral nervous system. In a typical emotional episode, an emotionally evocative event leads to changes in the peripheral nervous system, and this peripheral nervous system activity creates the sensations that we recognize as emotional feeling. Over a century after James proposed this idea, it remains a fundamental assumption in most modern theories of human emotion (e.g., Cacioppo, Berntson, & Klein, 1992; Damasio & Carvalho, 2013; Laird & Bresler, 1992; Lange, 1885; Levenson, Ekman, & Friesen, 1990; Russell, 1980; Scherer & Moors, 2019; Tomkins, 1962; Wood, Rychlowska, Korb, & Niedenthal, 2016). Yet, the claim that signals from the peripheral nervous system create emotional feeling is unsatisfyingly vague. It’s akin to saying that signals from the external environment create vision. Like vision, we want to know which systems are responsible for emotional experience. What are the “eyes of emotion” and how do these systems operate?

There are at least two reasons why researchers have struggled to elucidate the precise relationship between the peripheral nervous system and emotional experience. First, most components of the peripheral nervous system are *emotionally undifferentiated*, meaning that it is difficult to distinguish between different discrete emotions (e.g., happiness and fear) by looking at only a single component of the peripheral nervous system (Siegel et al., 2018). For example, happiness, fear, and sadness are generally indistinguishable based on heart rate and/or heart rate variability measurement alone (Siegel et al., 2018). Second, methods for *experimentally manipulating* components of the peripheral nervous system—such as heart rate variability biofeedback (Lehrer & Gevirtz, 2014), intensive exercise (Martin, Harlow, & Strack, 1992), epinephrine injections (Schachter & Singer, 1962), and fasting (MacCormack & Lindquist, 2018)—can involve extensive training, require expensive equipment, and/or face ethical constraints.

To develop precise models of the relationship between peripheral nervous system activity and emotional experience, it is useful to identify an emotionally differentiated component of the system that is easily, cost-effectively, and ethically amenable to experimental manipulation. I argue that motor feedback from the face—i.e., *facial feedback*—is an ideal candidate because (1) facial movements are more emotionally differentiated than other aspects of the peripheral nervous system (Allport, 1922; Ekman, 1971), (2) people most frequently and strongly emphasize changes in the face when specifying which bodily regions are active during an emotional episode (Hietanen, Glerean, Hari, & Nummenmaa, 2016; Nummenmaa, Glerean, Hari, & Hietanen, 2014), (3) healthy individuals can adjust their facial expressions voluntarily, precisely, and safely (Rinn, 1984), and (4) facial feedback research does not typically require advanced equipment.

The facial feedback hypothesis predicts that feedback from an individual's facial expressions influences their emotions—e.g., that smiling can make an individual feel happy and scowling can make them feel angry (Izard, 1977). This dissertation focuses on evaluating whether the facial feedback hypothesis is valid and developing a comprehensive framework that outlines potential roles of facial feedback in emotion. In Chapter 2, I review recent controversy surrounding the facial feedback hypothesis and introduce an ongoing international adversarial collaboration—the Many Smiles Collaboration—designed to address this controversy. In Chapter 3, I review a re-analysis of a facial feedback meta-analysis (Coles, Larsen, & Lench, 2019). This re-analysis reveals that available evidence cannot resolve theoretical disagreements identified by the Many Smiles Collaboration. In Chapters 4 and 5, I present three studies developed to test the facial feedback hypothesis and address disagreement from the Many Smiles Collaboration. These studies indicate that facial feedback can influence feelings of happiness and anger, but that the evidence is not equivocal. In Chapter 6, I highlight that it is still not clear *how* facial feedback influences emotion and suggest that existing mechanistic explanations can be productively subsumed under an integrative framework I call the Facial Feedback Component Process Framework (ffCPF).

Chapter 2: Uncertainty Surrounding the Facial Feedback Hypothesis

When this dissertation work began, there were competing narratives about the validity of the facial feedback hypothesis. On one hand, a large collaborative effort consistently failed to replicate a seminal demonstration of facial feedback effects (Wagenmakers et al., 2016). On the other hand, a meta-analysis supported the facial feedback hypothesis but provided little explanation for why some researchers have failed to replicate these effects (Coles, Larsen, & Lench, 2019). Consequently, I formed the Many Smiles Collaboration (henceforth referred to as the MSC). The MSC is an international group of researchers—some advocates of the facial feedback hypothesis, some critics, and some without strong beliefs—who came together to (1) specify and articulate their theoretical perspectives regarding when these effects, if real, should most reliably emerge (2) determine the best way(s) to test those beliefs, and (3) use this information to design and execute an international multi-lab experiment. In this chapter, I review the context surrounding the formation of the MSC and the outstanding disagreements amongst members of this collaboration.

Failure to Replicate the Original Pen-in-Mouth Study

In the most seminal facial feedback study to date, participants viewed humorous cartoons while holding a pen in their mouth in a manner that either produced a smile (pen held in teeth) or prevented smiling (pen held by lips; Strack, Martin, & Stepper, 1988). Consistent with the facial feedback hypothesis, participants induced to smile reported feeling more amused by cartoons than those who were prevented from smiling. These findings were influential because previous facial feedback experiments often explicitly instructed participants to pose a facial expression, which raised concerns about demand characteristics (Buck, 1980; Ekman & Oster, 1979; Zuckerman, Klorman, Larrance, & Spiegel, 1981). Furthermore, facial feedback theorists disagreed about whether these effects could occur outside of awareness (Ekman, 1979; Laird, 1974; Laird & Bresler, 1992). Since participants in this original pen-in-mouth study were presumably unaware they were smiling, the authors concluded that facial feedback effects were not driven by demand characteristics and could occur outside of awareness.

More recently, a collaborative effort involving 17 labs consistently failed to replicate this original pen-in-mouth study (Wagenmakers et al., 2016). However, the implications of this failure-to-replicate for the facial feedback hypothesis are unclear. One simple possibility is that the facial feedback hypothesis may be false. However, this conclusion is beyond the scope of the direct replication because it was limited to a specific test of the facial feedback hypothesis. Indeed, the replicators were careful to point out that their findings “do not invalidate the more general facial feedback hypothesis” (Wagenmakers et al., 2016; p. 924). Similarly, while arguing that the pen-in-mouth effect is unreliable, Schimmack and Chen (2017) conceded that “other paradigms may produce replicable results” (para. 23).

A second possibility is that both the facial feedback hypothesis and the original pen-in-mouth effect are true (Table 1). If this is the case, researchers must determine why others were unable to replicate these real effects. One suggestion is that the replicators did not perform a true direct replication because they deviated from the original study by overtly recording participants (Strack, 2016). According to this explanation, awareness of video recording may induce a self-focus that interferes with participants’ emotional experience. To examine this possibility, Noah, Schul, and Mayo (2018) manipulated awareness of video recording while participants completed the pen-in-mouth task. Although evidence of an interaction between awareness of video recording and pen-in-mouth task was weak[1], follow-up contrasts indicated that there was only a significant pen-in-mouth effect when participants were unaware of video recording. (Conflicting meta-analytic evidence will be reviewed later.)

[1] In Noah et al (2018), the critical interaction between awareness of video recording and the pen-in-mouth task was slightly above conventional cut-offs for declaring statistical significance (*p* = .051). Bayes Factor indicates that the evidence provides only weak or anecdotal evidence of a non-zero interaction effect (Jarosz & Wiley, 2014).

Table 1. Evidence for and against potential explanations for the pen-in-mouth failure to replicate

Possible states of the world	**Explanation for failure-to-replicate**	**Evidence from primary research**	**Evidence from Coles, Larsen, and Lench (2019) meta-analysis**
The facial feedback hypothesis and pen-in-mouth effect are both valid.	Awareness of video recording interferes with facial feedback effects.	Noah, Schul, and Mayo (2018) manipulated awareness of video recording and found that the pen-in-mouth task only produced significant facial feedback effects when participants were unaware of video recording.	Facial feedback studies that overtly recorded participants yielded similar effect sizes as studies that either covertly recorded or did not record participants.
The facial feedback hypothesis is valid, but the pen-in-mouth effect is not.	Facial feedback effects only occur when participants are aware they are posing a facial expression.	N/A	Facial feedback studies that used tasks that presumably led to less awareness yielded similar results as studies that used tasks that led to more awareness. However, the overall effect size from the few studies that used lower-awareness tasks was not statistically significant (p = .15).
	Facial feedback effects only emerge when the patterns of facial movements resemble a prototypical facial expression of emotion.	Soussignan (2002) only found facial feedback effects when participants posed more prototypical expressions of happiness. However, Kraft and Pressman (2012) found that the effect was small but still significant when participants posed less prototypical expressions of happiness.	N/A. Researchers did not provide enough detail about participants' facial movements to test this potential moderator.
	Facial feedback influences internal-focused but not external-focused emotional experience.	N/A	After controlling for publication bias, facial feedback studies only yield significant effects when they examine internal-focused emotional experience.

A third possibility is that the facial feedback hypothesis is true, but not under the context examined in the original pen-in-mouth study (Table 1). Perhaps facial feedback effects only occur when participants are aware they are posing a facial expression (Laird, 1974; Laird & Bresler, 1992), a mechanism that the original pen-in-mouth study was designed to eliminate (Strack et al., 1988). Alternatively, perhaps the pen-in-mouth task is a poor manipulation of facial feedback. Indeed, some theorists have predicted that facial feedback effects will only emerge when the patterns of facial movements resemble a prototypical facial expression of emotion (Ekman, 1993; Hager & Ekman, 1981; Levenson et al., 1990; Levenson, Ekman, Heider, & Friesen, 1992; Matsumoto, 1987; Tomkins, 1981). Although the pen-in-mouth task is designed to make participants express happiness, some research indicates that this task does not reliably produce prototypical expressions of happiness (Soussignan, 2002), a smile that is accompanied by the contraction of the *orbicularis oculi* muscles surrounding the eyes (Ekman, Davidson, & Friesen, 1990).

To test if the prototypicality of posed expressions moderates facial feedback effects, Soussignan (2002) introduced two variants of the pen-in-mouth procedure—one that led to more prototypical expressions of happiness and one that led to less—and found that only the former produced a significant facial feedback effect. This suggests that facial feedback effects might be eliminated when facial movements do not resemble prototypical emotional expressions. However, in a larger study, Kraft and Pressman (2012) found that both variants of the pen-in-mouth procedure influenced emotional experience, but that the more prototypical happiness poses had a larger effect. Given the large sample size in Wagenmakers and colleagues' (2016) failure-to-replicate (n = 2,262), they likely had high power to detect facial feedback effects from less prototypical facial movements. However, since participants in this study were not asked for permission to share data collection recordings, it is impossible to evaluate the degree to which the facial movements resembled prototypical expressions of happiness—if at all.

Another possibility is that facial feedback may only influence certain types of emotional experiences. Some researchers distinguish between internal- and external-focused emotional experience, with the former focused on what is happening in the body and the latter focused on what is happening in the environment (Frijda, 2010; Laird & Bresler, 1992; Lambie & Marcel, 2002). Facial feedback theories have traditionally emphasized internal-focused emotional experience. However, in the original pen-in-mouth study, participants were asked how amused they felt *by the cartoons*, which may be a more external-focused emotional experience. Therefore, one possibility is that facial feedback only influences internal-focused emotional experience, although no study to date has experimentally investigated this possibility.

To summarize, the failure-to-replicate does not provide a test of the validity of the facial feedback hypothesis more generally because it is limited to a narrow operationalization of the hypothesis. Furthermore, researchers can offer several explanations for why the facial feedback hypothesis is valid despite difficulty replicating the original pen-in-mouth effect. Consequently, to examine the facial feedback hypothesis more comprehensively, researchers turned their attention to the cumulative evidence via meta-analysis.

Cumulative Evidence for the Facial Feedback Hypothesis

Amid the uncertainty created by the failure-to-replicate, Coles, Larsen, and Lench (2019) performed a meta-analysis on 286 effect sizes from 137 studies testing the effects of various facial feedback manipulations on emotional experience. Results indicated that facial feedback has a small but highly varied effect on emotional experience. Notably, this effect could not be explained by publication bias. Published and unpublished studies yielded effects of a similar magnitude, a variety of publication bias analyses failed to uncover significant evidence of publication bias, and bias-corrected overall effect size estimates were significant.

This meta-analysis also revealed that facial feedback effects tend to be larger in certain circumstances (e.g., in the absence vs. presence of emotional stimuli). However, these moderator analyses could not fully account for why Wagenmakers and colleagues (2016) failed to replicate the pen-in-mouth effect (Table 1). For example, although Strack (2016) and Noah et al. (2018) suggested that awareness of video recording interferes with facial feedback effects, the meta-analysis revealed that studies produced significant facial feedback effects regardless of whether participants were overtly recorded. Furthermore, although some theorists have predicted that facial feedback effects will only emerge when the patterns of facial movements resemble a prototypical emotional facial expression (Ekman, 1993; Hager & Ekman, 1981; Levenson et al., 1990, 1992; Matsumoto, 1987; Tomkins, 1981), researchers did not provide enough detail about participants' facial movements to test this potential moderator.

The meta-analysis provided mixed evidence of whether facial feedback effects only occur when participants are aware they are posing a facial expression (Laird, 1974; Laird & Bresler, 1992). Studies that used facial feedback tasks that presumably led to less awareness yielded similar results as studies that used tasks that led to more awareness. However, the overall effect size from the few studies that used lower-awareness tasks was not statistically significant (p = .15). Nevertheless, the meta-analysis did indicate that, after controlling for publication bias, facial feedback studies only yield significant effects when they examine internal-focused emotions. Thus, the meta-analysis provided evidence of one moderator that may explain why Wagenmakers and colleagues (2016) failed to replicate the pen-in-mouth effect.

Although the meta-analysis seems to indicate that the facial feedback hypothesis is valid, there are at least three limitations that could undermine this conclusion. First, absence of evidence cannot be taken as evidence of the absence of publication bias, especially since these analyses often have poor ability to detect and correct for bias (Carter, Schönbrodt, Gervais, & Hilgard, 2019; Macaskill, Walter, & Irwig, 2001; Stanley, 2017). Consequently, it is possible that seemingly robust facial feedback effects are driven by studies that used undetected questionable research practices (John, Loewenstein, & Prelec, 2012). Second, it is possible that the overall effect size estimates in this literature are driven by low-quality studies, such as studies that created demand characteristics or used improper randomization procedures (Eysenck, 1978). Third, even relatively similar subsets of facial feedback studies varied beyond what would be expected from sampling error alone, meaning that moderator analyses had low power and potentially contained unidentified confounds. Consequently, the meta-analysis could not reliably identify moderators that may help explain why some researchers fail to observe facial feedback effects.

The Many Smiles Collaboration

Both the failure-to-replicate the original pen-in-mouth study and the meta-analysis have a unique set of limitations that make it difficult to resolve the debate regarding whether the facial feedback hypothesis is valid. Consequently, I formed the Many Smiles Collaboration (MSC). The MSC is an international group of researchers—some advocates of the facial feedback hypothesis, some critics, and some without strong beliefs—who came together to: (1) specify their beliefs regarding when facial feedback effects, if real, should most reliably emerge, (2) determine the best way(s) to test those beliefs, and (3) use this information to design and execute an international multi-lab experiment.

Formation of the Many Smiles Collaboration.

The MSC began in February 2018 as a two-lab collaboration between me and Fernando Marmolejo-Ramos (University of Adelaide). In the original research proposal, I specified what I believed were the simplest necessary condition for facial feedback effects to emerge and proposed testing these conditions in a three-lab collaboration. While recruiting a third lab, Fernando and I discovered that there was an overwhelming amount of interest in this project. Consequently, I announced an open invitation to join the MSC via Twitter, Facebook, and email. MSC membership grew on a rolling basis, and MSC members were asked to review and suggest changes to the initial study design. The major disagreements that were identified through this process are reviewed below.

As the MSC grew, I restructured the collaboration to include (a) three consultants, who were asked to serve as a hypothesis-advocate (Fritz Strack), hypothesis-critic (Phoebe Ellsworth), and hypothesis-agnostic (Lowell Gaertner), and (b) two neutral statistician who would assist with power simulations, the data analysis strategy, and final data analyses. At the time of writing this dissertation, the MSC contains 28 research teams from 20 countries who speak a total of 14 languages (Figure 1). The project has in-principle acceptance pending minor revision at *Nature Human Behavior*, and international data collection is projected to begin in Fall 2020 (Coles, March, et al., 2019). In Chapter 4, I review two pilot studies that stemmed from the MSC.

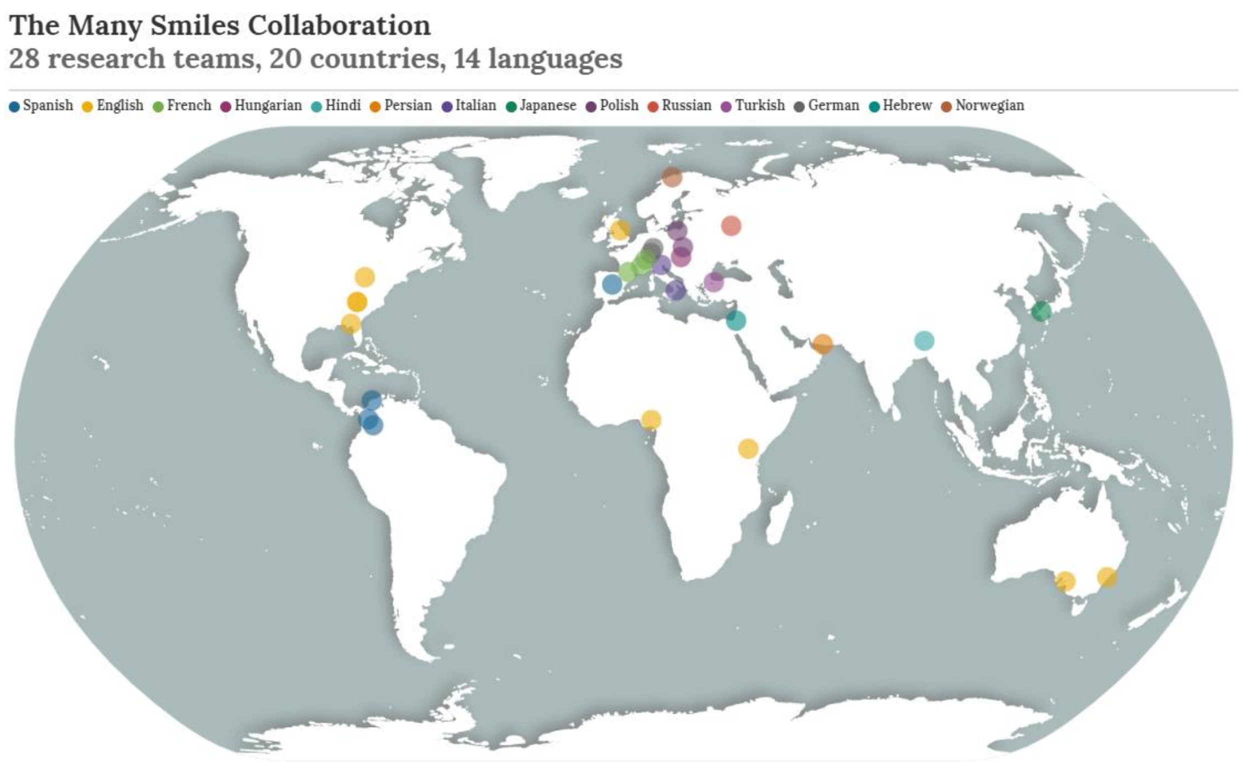

Figure 1. Team composition of the Many Smiles Collaboration (as of March 31st, 2020).

Disagreements amongst members of the Many Smiles Collaboration.

The MSC agreed that one of the simplest necessary conditions for facial feedback effects to emerge is that participants adopt a facial posture resembling an emotional expression and subsequently provide self-reports of the associated emotional state. However, the MSC disagreed about (1) whether facial feedback can initiate emotional experiences or only modulate ongoing emotional experiences, and (2) the degree to which a facial pose must resemble a prototypical emotional expression.

Initiation vs. modulation of emotional experience.

Members of the MSC primarily disagreed about whether facial feedback can only modulate ongoing emotional experiences (e.g., those elicited by other emotional stimuli) or also initiate emotional experiences in otherwise non-emotional situations. Many theories predict that facial feedback can only modulate emotional experience (Allport, 1922; Gellhorn, 1958, 1964). Indeed, one of the first facial feedback theorists suggested that the autonomic nervous system creates undifferentiated feelings of positivity and negativity that are subsequently categorized into emotional groups based on patterns of facial feedback (Allport, 1922). By this account, scowling can lead people to categorize their ongoing feelings of negativity as anger, but scowling cannot initiate the experience of anger in the absence of ongoing feelings of negativity. Other facial feedback theories contend that facial feedback can also initiate emotional experience (Berkowitz, 1990; Ekman, 1979). For example, one theory posits that facial expressions (e.g., scowling) can activate innate affect programs, triggering a set of coordinated emotional responses that contribute to the experience of the corresponding emotion (e.g., anger; Levenson et al., 1990).

Meta-analysis indicated that facial feedback can both initiate and modulate emotional experience (Coles, Larsen, & Lench, 2019). However, the only two studies to experimentally manipulate whether participants were exposed to emotional stimuli found that facial feedback neither initiated nor modulated emotional experiences (Reisenzein & Studtmann, 2007; Tourangeau & Ellsworth, 1979). Consequently, disagreements about whether facial feedback can initiate and/or modulate emotional experience were considered unresolved.

Prototypicality of posed expression.

Following failures to demonstrate facial feedback effects early in the history of research on the facial feedback hypothesis (Tourangeau & Ellsworth, 1979), many researchers speculated that facial feedback effects only emerge when participants' facial expressions closely resemble prototypical emotional expressions (Ekman, 1993; Hager & Ekman, 1981; Levenson et al., 1990, 1992; Matsumoto, 1987; Tomkins, 1981). However, as reviewed earlier, previous research indicates that it is not clear whether facial feedback effects are eliminated (Soussignan, 2002) versus simply attenuated (Kraft & Pressman, 2012), when the posed expressions do not resemble prototypical emotional expressions. Consequently, this disagreement was considered unresolved.

Addressing disagreements amongst members of the Many Smiles Collaboration.

To address the disagreements identified by members of the MSC, I first performed a re-analysis of the Coles et al. (2019) meta-analysis to examine which types of emotional experiences can be initiated and modulated (Chapter 3). Then, I completed two experiments where I manipulated (a) whether emotions were being initiated vs. modulated and (b) whether the posed expressions were more vs. less prototypical (Chapter 4).

Chapter 3: Which Emotions Can Facial Feedback Initiate and Modulate? A Secondary Analysis of Coles, Larsen, and Lench (2019)

Although Coles et al. (2019) indicated that facial feedback can both initiate and modulate emotional experiences, they did not perform follow-up analyses that specified *which types* of emotional experiences can be initiated and modulated. For example, perhaps facial feedback can both initiate and modulate feelings of happiness, but only modulate feelings of surprise. Intuitively, this would make sense; People sometimes report feeling happy for no apparent reason, but they rarely say the same about feelings of surprise. To explore these kinds of possibilities further, I performed a secondary analysis of the Coles et al. (2019) meta-analysis, examining whether facial feedback can initiate and modulate feelings of happiness, anger, disgust, fear, sadness, and surprise.

Method

Coles et al. (2019) identified 128 effect sizes (*k*) from 56 studies (*s*) that tested whether facial feedback could initiate or modulate feelings of happiness, anger, disgust, fear, sadness, and surprise. This database can be conceptualized as having a 2 (initiation or modulation) x 6 (happiness, anger, disgust, fear, sadness, or surprise) unbalanced structure. Studies were considered tests of initiation effects if no emotional stimuli (or only neutral stimuli) were presented to participants during the study (see Coles et al. 2019 for more details). Studies were considered tests of modulation effects if emotional stimuli were presented either before, during, or after participants engaged in the facial feedback task. For ease of comparison, Coles et al. (2019) only included expression-congruent outcomes. For example, the effects of smiling on happiness were included, but the effects of frowning on happiness were not. Cohen's standardized *d* was used as the effect size index, which represents the difference between two group means divided by their pooled standard deviation (Borenstein, 2009; Cohen, 1988). These effect sizes were calculated so that positive values indicated an effect consistent with the facial feedback hypothesis.

Many studies in this dataset provided multiple effect sizes of interest (e.g., multiple measures of happiness). This violates the assumption that effect sizes are independent. This dependency issue can be addressed with multi-level meta-regression (Van den Noortgate, Lopez-Lopez, Marin-Martinez, & Sanchez-Meca, 2015), cluster-robust variance estimates (Hedges, Tipton, & Johnson, 2010), or meta-analysis with aggregated dependencies (Borenstein, Hedges, Higgins, & Rothstein, 2009). These three approaches yielded similar overall effect size estimates. Therefore, I focus on the results from the simpler meta-analyses with aggregated dependency.

To calculate overall effect size estimates corrected for publication bias, I used trim-and-fill (Duval & Tweedie, 2000), precision-effects tests (PET and PEESE; Stanley & Doucouliagos, 2014), and weight-function modeling (Vevea & Hedges, 1995). Publication bias analyses were not conducted on subgroups with too few observations (i.e., less than three studies). For example, only one study has examined whether facial feedback can initiate feelings of surprise, so publication bias analyses were not performed on this subgroup.

Results

Although Coles et al. (2019) indicated that facial feedback can both initiate and modulate emotional experiences, examining which types of emotional experiences these effects apply to provides an inconsistent pattern of results.

For initiation effects, meta-analyses unadjusted for publication bias indicated that facial feedback can initiate feelings of happiness ($s = 8$, $d = 0.47$, $p = .03$), anger ($s = 6$, $d = 0.64$, $p <$

.001), disgust (*s* = 8, *d* = 0.61, *p* = .01), fear (*s* = 7, *d* = 0.25, *p* < .001), and sadness (*s* = 8, *d* = 0.51, *p* = .01), but not feelings of surprise (*s* = 1, *d* = 0.26, *p* = .30). However, after controlling for publication bias, most of these initiation effects were no longer statistically significant (Table 2). The only exception was the overall effect in studies examining whether facial feedback can initiate feelings of sadness, which was generally robust across publication bias analyses. However, in many circumstances, publication bias analyses yielded estimates of *reverse* publication bias, provided *larger* bias-corrected overall effect size estimates, but indicated these bias-corrected overall effect size estimates were *not* significant. Furthermore, publication bias analyses sometimes yielded conflicting patterns of results. For example, for happiness initiation effects, weight-functioning modeling yielded some evidence of publication bias, but PET and PEESE yielded estimates of *reverse* publication bias. These diverging patterns results likely emerged because most the data are characterized by a large degree of heterogeneity (i.e., between-study variation), which leads most publication bias analyses to have poor error rates (Carter et al., 2019; Macaskill et al., 2001; Stanley, 2017).

For studies examining modulation effects, meta-analyses unadjusted for publication bias indicated that facial feedback can modulate feelings of happiness (*s* = 3, *d* = 0.19, *p* = .01) and sadness (*s* = 9, *d* = 0.27, *p* = .01). The sadness modulation effect, however, was not statistically significant after controlling for publication bias. Surprisingly, results did not provide significant evidence that facial feedback can modulate feelings of anger (*s* = 9, *d* = 0.25, *p* = .06), disgust (*s* = 4, *d* = 0.08, *p* = .23), fear (*s* = 29, *d* = -0.14, *p* = .22), or surprise (*s* = 2, *d* = -0.32, *p* = .40).

Table 2. Secondary subgroup analyses of the Coles, Larsen, and Lench (2019) meta-analysis. Subgroup analyses examine whether facial feedback can initiate or modulate feelings of happiness, anger, disgust, fear, sadness, or surprise.

				unadjusted model			PET		PEESE		weight-function modeling	
Emotion	Subgroup	*s*	*k*	*d*	τ^2	*p*	*d*	*p*	*d*	*p*	*d*	*p*
Happiness	Initiation	8	10	0.47	0.29	.03	2.45[R]	.27	1.48[R]	.20	0.16	.69
	Modulation	3	8	0.19	0.12	0.01	1.05[R]	.02	0.53[R]	.02	0.41[R]	.01
Anger	Initiation	6	8	0.64	0.24	< .001	1.02[R]	.33	0.79[R]	.13	0.43	.23
	Modulation	9	15	0.25	0.01	.06	0.49[R]	.63	0.36[R]	.49	0.21	.19
Disgust	Initiation	8	10	0.61	0.26	.01	0.44	.56	0.48	.27	0.82[R]	.01
	Modulation	4	5	0.08	0	.23	-0.14	.53	-0.03	.81	0.05	.49
Fear	Initiation	7	9	0.25	0	< .001	0.32[R]	.13	0.26	.03	0.17	.12
	Modulation	29	34	-0.14	0	.22	-0.36	.34	-0.23	.24	-0.13	.95
Sadness	Initiation	8	10	0.51	0.27	.01	1.29[R]	.12	0.84[R]	.05	0.87[R]	< .01
	Modulation	9	10	0.11	0	.03	0.06	.66	0.10	.18	0.11	.42
Surprise	Initiation	1	2	0.26	0	.30	—	—	—	—	—	—
	Modulation	2	7	-0.32	0.22	.40	—	—	—	—	—	—

Note. *s* = number of studies; *k* = number of effect size estimates; *d* = Cohen's standardized difference; τ^2 = between study variance. The total dataset contains 56 studies and 128 effect sizes. Since many studies provided multiple effect sizes of interest, the sum of the *s* column exceeds 56. Due to a small number of studies and effect sizes, bias-corrected estimates were not computed for studies examining surprise.

Discussion

Although Coles et al. (2019) indicated that facial feedback can initiate and modulate emotional experience, secondary analyses indicate that it is actually unclear which types of emotional experiences these effects might apply to. Many of these analyses likely had low power to detect significant facial feedback effects (e.g., due to a small number of studies), but the conclusions nevertheless represent the cumulative evidence that exists thus far. Consequently, the debate amongst members of the Many Smiles Collaboration regarding whether facial feedback can initiate vs. modulate emotional experience was considered unresolved.

Chapter 4: Initial Tests from the Many Smiles Collaboration (Studies 1 and 2)

In the Many Smiles Collaboration (MSC), we sought to test whether posing happy facial expressions influences feelings of happiness. Furthermore, we sought to address disagreements about (1) whether facial feedback can initiate vs. modulate feelings of happiness, and (2) whether happy poses must resemble a prototypical expression of happiness for the effects to emerge. Consequently, the MSC designed a 2 (type of pose: happy or neutral) x 2 (facial feedback task: facial mimicry or voluntary facial action technique) x 2 (stimuli presence: present or absent) design, with type of pose manipulated within-participants and facial feedback task and stimuli presence manipulated between-participants (Figure 2).

To provide an easy-to-follow task that would produce more prototypical facial expressions, the MSC elected to use a facial mimicry paradigm, wherein participants were shown images of actors displaying prototypical expressions of emotion and later asked to mimic the expressions (Kleinke, Peterson, & Rutledge, 1998). Such mimicry manipulations are susceptible to demand characteristics and emotional contagion effects (Hatfield, Cacioppo, & Rapson, 1993), so the MSC elected to also have some participants use the voluntary facial action technique (Dimberg & Söderkvist, 2011). This technique involves asking participates to contract their facial muscles in a way that resembles an emotional expression. We expected that the voluntary facial action technique would produce less prototypical emotional expressions but be less susceptible to demand characteristics and emotion contagion effects. The MSC also elected to manipulate whether participants were exposed to positive stimuli while engaging in the facial feedback tasks. Before executing this MSC study globally, I tested the design in two pre-registered studies completed at the University of Tennessee.

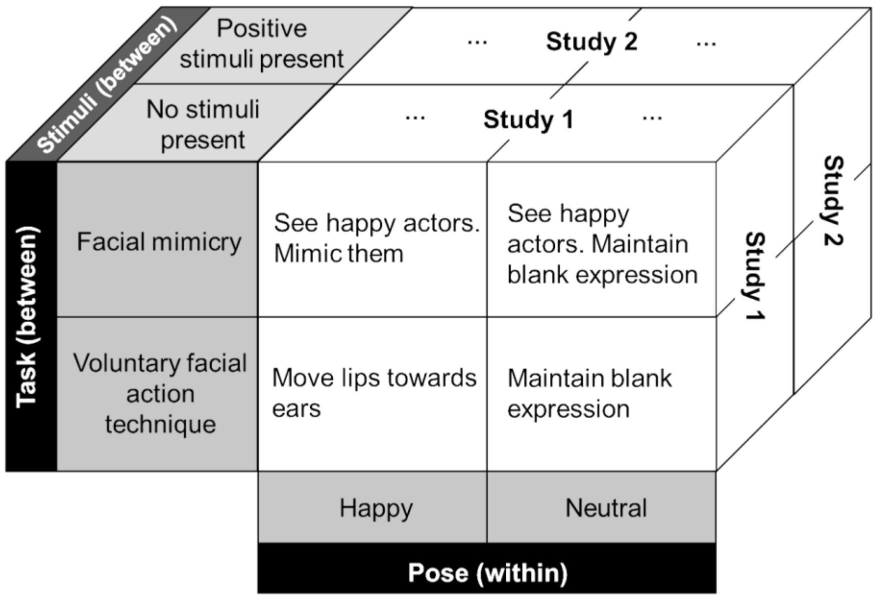

Figure 2. Combined experimental design of Studies 1 and 2.

Method

The two pre-registered studies used a 2 (type of pose: happy or neutral) x 2 (facial feedback task: facial mimicry or voluntary facial action technique) design. The two studies differed in whether participants viewed emotional stimuli while engaging in the critical poses, with the first pilot testing initiating effects (i.e., no stimuli present) and the second pilot testing modulating effects (i.e., stimuli present). Combined, the two studies form a 2 (type of pose: happy or neutral) x 2 (facial feedback task: facial mimicry or voluntary facial action technique) x 2 (stimuli presence: present or absent) design (Figure 2). Patterns of data and inferences were identical across the two studies, so pooled analyses are reported unless otherwise noted.

Together, data were collected from 206 participants (67% female; age M = 18.52, SD = 0.96). Participants were run in a laboratory, and the experiment was presented through Qualtrics. To avoid concerns about whether awareness of video recording interferes with facial feedback effects (Noah et al., 2018; Strack, 2016), participants were covertly recorded throughout the first study.

Participants were told that the experiment investigated how physical movements and cognitive distractors influence mathematical speed and accuracy and that the computer would randomly assign them to complete five movement tasks and simple math problems. The first, second, and last tasks were filler trials included to ensure the cover story was believable ("Place your left hand behind your head and blink your eyes once per second for 10 seconds", "Touch your right ear with your left hand and hold this position for 10 seconds", and "Tap your left leg with your right-hand index finger once per second for 6 seconds"). In the two critical tasks, participants were asked to pose happy and neutral facial expressions (in randomized order) through either the facial mimicry procedure or the voluntary facial action technique. While posing these expressions, some participants were randomly assigned to view positive images. To reinforce the cover story, participants were provided with an on-screen timer during all tasks.

After each task (including filler tasks), participants completed two randomly-presented simple filler arithmetic problems and the Discrete Emotions Questionnaire's 4-item happiness subscale (C. Harmon-Jones, Bastian, & Harmon-Jones, 2016). To further obscure the purpose of the study, participants also answered four filler items from the anger subscale and two filler items from the anxiety subscale of the Discrete Emotions Questionnaire. When answering these questions, participants were asked to report the extent they experienced these feelings during the preceding task. Notably, by not referencing the emotional stimuli, this questionnaire better captured internal-focused, as opposed to external-focused, emotional experience (Frijda, 2010; Lambie & Marcel, 2002).

In the facial mimicry condition, participants were shown a 2 x 2 matrix of actors posing happy expressions. Participants were then instructed to either (a) mimic these expressions (happy condition), or (b) maintain a blank expression (neutral condition). Importantly, having participants view the happy expression matrix in both the happy and neutral trials ensured that any potentially confounding effects that images of smiling people have on emotional experience were held constant. The expression matrix was displayed for at least 5 seconds, and participants indicated when they were ready to perform the mimicry task. In the voluntary facial action technique condition, participants were instructed to either (a) move the corner of their lips up towards their ear and elevate their cheeks using only the muscles in their face (happy condition), or (b) maintain a blank facial posture (neutral condition). In both the facial mimicry and voluntary facial action technique conditions, participants were instructed to maintain the poses for 5 seconds, the approximate duration of spontaneous happiness expressions (Ekman, 2003).

After completing the five movement tasks, participants answered a variety of open-ended questions regarding their beliefs about the purpose of the experiment in a funneled debriefing, wherein they were gradually informed of the true nature of the study. Afterwards, the experimenter rated the degree to which the participant was aware of the experimental hypothesis.

Materials.

In the facial mimicry conditions, participants viewed a 2 x 2 matrix of models posing happy facial expressions from the Extended Cohn-Kanade Dataset (Figure 3; Lucey et al., 2010). All four models posed prototypical facial expressions of happiness, as confirmed by coders trained in the Facial Action Coding System (Ekman & Rosenberg, 1997). All models also gave permission for their photographs to be shared openly. A matrix of actor images, as opposed to a single image, was used so that participants had multiple examples of the movement and were provided with more options for a suitable facial model.

During the two critical posing tasks, one group of participants viewed an array of four positive photos (Figure 4). A matrix of photos (as opposed to a single photo) was used to increase the probability that participants would find at least one of the photos to be emotionally evocative. All photos were drawn from a database comprising 100 images from the Internet and the International Affective Picture System (Lang & Bradley, 2007) that were rated on how good (50 coders) and bad they were (51 coders) on a 7-point scale (1 = “not at all” to 7 = “extremely”; March, Gaertner, & Olson, 2017).

Figure 3. Image matrix of actors posing happy expressions shown to participants in the Studies 1 and 2 mimicry conditions. Participants were instructed to either mimic these faces or maintain a blank pose.

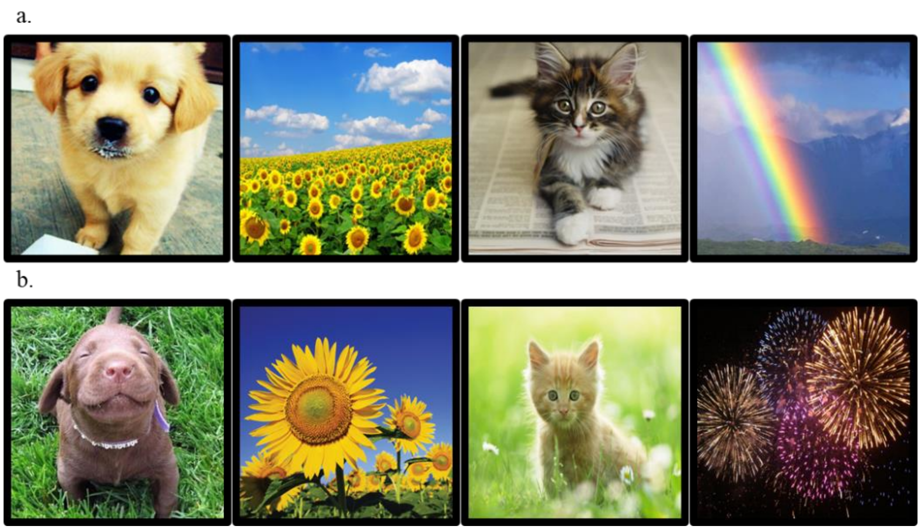

Figure 4. Images shown to Studies 1 and 2 participants in the condition testing whether posing happy expressions can modulate feelings of happiness. One set of images (either a or b) were shown during the happy pose trials and the other was shown during the neutral pose trials (counterbalanced).

Results

To examine whether facial feedback impacted self-reported happiness, a 2 (type of pose: happy or neutral) x 2 (facial feedback task: facial mimicry or voluntary facial action technique) x 2 (stimuli presence: absent or present) mixed-effect ANOVA was fitted, with type of pose included as a within-participant factor. Consistent with the facial feedback hypothesis, participants reported more happiness after posing happy (*M* = 2.47, *SD* = 1.48) vs. neutral expressions (*M* = 1.93, *SD* = 1.18), $F(1, 202) = 43.65$, $p < .001$, $\eta^2_G = 0.04$ (Figure 5). No main effect for facial feedback task was detected, $F(1, 202) = .38$, $p = .54$, $\eta^2_G = 0.00$. There was also a main effect for stimuli presence, wherein participants reported more happiness when positive stimuli were present (*M* = 2.65, *SD* = 1.54) vs. absent (*M* = 1.72, *SD* = 0.94), $F(1, 202) = 36.06$, $p < .001$, $\eta^2_G = 0.08$.

Results also revealed an interaction between facial feedback task and stimuli presence, $F(1, 202) = 5.79$, $p = .02$, $\eta^2_G = 0.01$. To decompose this interaction, 2 (type of pose: happy or neutral) x 2 (facial feedback task: facial mimicry or voluntary facial action technique) mixed ANOVAs were separately fitted for each study. Simple effects of pose were obtained both when stimuli were absent ($F(1, 98) = 15.56$, $p < .001$, $\eta^2_G = 0.03$) and present, $F(1, 104) = 29.40$, $p < .001$, $\eta^2_G = 0.06$. These findings indicate that smiling both initiated and modulated feeling of happiness, and that smiling had a stronger modulating effect.[2]

[2] Some may argue that the inclusion of the mimicry condition prevented a true test of the initiation hypothesis because images of smiling actors may elicit happiness (Hatfield, Hsee, Costello, & Weisman, 1995). This seems unlikely because participants did not report more happiness in the mimicry vs. voluntary facial action technique condition. Nevertheless, follow-up analyses excluding the mimicry condition confirmed that facial feedback can initiate emotional experience, $F(1, 50) = 6.76$, $p = .01$, $\eta^2_G = 0.04$.

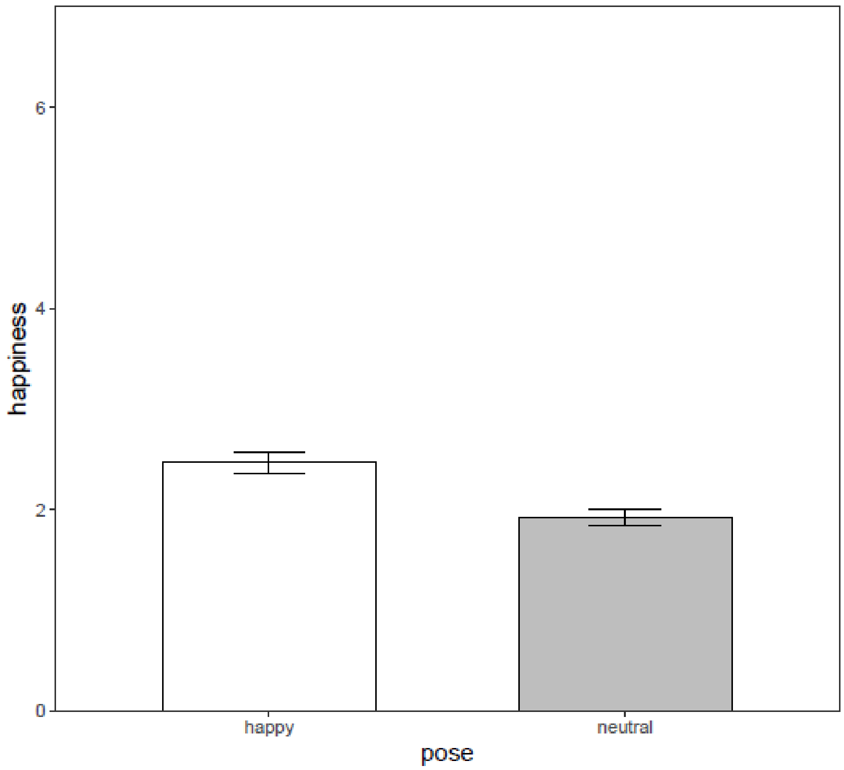

Figure 5. Self-reported happiness after posing happy and neutral expressions in Studies 1 and 2.

One alternative explanation for this pattern of results is that participants found the smiling task to be less boring than the neutral task (perhaps because participants do not do anything with their bodies in this latter task). The three filler trials allowed us to provide a *post hoc* test of this possibility because they required participants to perform affectively neutral bodily movements. We therefore compared happiness ratings during the happy vs. filler trials using a 2 (trial type: happy or filler) x 2 (stimuli presence: absent or present) linear mixed-effect model. Consistent with the facial feedback hypothesis, results revealed that participants reported greater happiness after posing happy expressions (M = 2.47, SD = 1.48) vs. engaging in filler tasks (M = 1.86, SD = 1.01), $F(1, 616) = 110.25$, $p < .001$. Results also revealed an interaction between facial feedback task and stimuli presence, $F(1, 616) = 69.42$, $p < .001$. To decompose this interaction, we re-examined the main effect of pose separately for each study. Simple effects of pose were obtained both when stimuli were absent ($F(1, 299) = 3.97$, $p = .047$) and present ($F(1, 317) = 130.43$, $p < .001$). Taken together, this provides further evidence in favor of the facial feedback hypothesis.

Participant awareness.

To assess awareness, experimenters rated the degree to which participants were aware of the purpose of the experiment based on their in-person funnel debriefing responses (1 = “not at all aware” to 5 = “completely aware”). Results indicated that participants generally exhibited low awareness of the purpose of the experiment (M = 1.54, SD = 0.96), with 85% of participants characterized as not at all or slightly aware. To examine whether participant awareness varied across conditions, awareness ratings were modeled using a 2 (facial feedback task: facial mimicry or voluntary facial action technique) x 2 (stimuli presence: present or absent) ANOVA. Contrary to the MSC’s prediction, results did not indicate that participants were more aware of the purpose of the experiment in the facial mimicry (*M* = 1.47, *SD* = 0.85) vs. voluntary facial action technique (*M* = 1.61, *SD* = 1.06) condition, $F(1, 202) = 1.04$, $p = .31$, $\eta^2_G = 0.00$. Unexpectedly, participants exhibited slightly more awareness of the experiment's purpose when emotional stimuli were present (*M* = 1.68, *SD* = 1.03) as opposed to absent (*M* = 1.39, *SD* = 0.86), $F(1, 202) = 4.78$, $p = .03$, $\eta^2_G = 0.01$. No interaction between awareness and stimuli presence was detected, $p = .49$.

Although these studies provide evidence in favor of the facial feedback hypothesis, it is possible that these effects were driven by participants' awareness of the purpose of the experiment (e.g., demand characteristics). When the confirmatory analyses were re-run with participant awareness included as a moderator, results provided some evidence that facial feedback effects were larger when participants are more aware of the purpose of the experiment (pooled $F(1, 198) = 5.48$, $p = .02$; Study 1 $F(1, 96) = 0.66$, $p = .42$; Study 2 $F(1, 102) = 6.27$, $p = .01$). Consequently, all confirmatory analyses we re-run excluding participants who exhibited any degree of awareness (i.e., had an awareness score higher than 1). Critically, all the results were robust except the interaction between facial feedback task and stimuli presence (Pose main effect: $F(1, 139) = 19.75$, $p < .001$; Task main effect: $F(1, 139) = 1.56$, $p = .21$; Stimuli presence main effect: $F(1, 139) = 24.89$, $p < .001$; All higher order interaction *p*s > .26). Taken together, the observation of a significant facial feedback effect in participants who were completely unaware of the purpose of the experiment indicates that awareness of the purpose of the experiment does not fully account for these results. At the same time, results from the moderator analysis suggest that being aware of the hypothesis can amplify facial feedback effects.

Prototypicality of posed expressions.

In pilot study 1, participants were covertly recorded to assess the quality of their posed expressions. For participants who consented for their videos to be analyzed (n = 80), video recordings of their neutral and happy posing trials were processed through Noldus FaceReader 7.0, which provided moment-to-moment ratings of expressed happiness (0 to 1; Lewinski, den Uyl, & Butler, 2014). FaceReader failed to code videos from two participants, leaving a final sample of 78 pairs of videos.

Expressed happiness ratings were modeled using a 2 (type of pose: happy or neutral) x 2 (facial feedback task: facial mimicry or voluntary facial action technique) mixed-effect ANOVA, with type of pose included as a within-participant factor. As expected, participants expressed more happiness during the happy (M = .65, SD = .27) vs. neutral (M = .03, SD = .05) trials, $F(1, 76) = 454.61$, $p < .001$. Participants also expressed more happiness in the facial mimicry (M = .39, SD = .39) vs. voluntary facial action technique (M = .28, SD = .34) condition, $F(1, 76) = 14.59$, $p < .001$. These main effects were qualified by a significant interaction, wherein the difference in expressed happiness between the happy and neutral trials was larger in the facial mimicry condition, $F(1, 76) = 14.69$, $p < .001$. These patterns of results are consistent with the MSC's prediction that the facial mimicry condition would produce more prototypical expressions of happiness than the voluntary facial action technique condition, although results so far provide little evidence that high vs. low quality poses influences the magnitude of facial feedback effects. In addition, all but one participant expressed more happiness during the happy vs. neutral trial, indicating that most participants successfully executed the two facial feedback tasks.

Chapter 5: A Conceptual Replication with Anger (Study 3)

Initial tests of the Many Smiles Collaboration methodology indicated that (1) posing a happy expression can both initiate and modulate feelings of happiness, (2) these effects emerge even when the pose does not produce a prototypical expression of happiness, and (3) these effects are not fully accounted for by awareness of the purpose of the experiment. However, do these conclusions generalize to other posed expressions of emotion? To begin to answer this question, I examined the effects of scowling on feelings of anger. I chose anger (as opposed to other discrete emotions, such as sadness or fear) because angry expressions are easy to reproduce in the lab (i.e., participants can easily furrow their brow). Furthermore, facial feedback effects appear to be the largest for anger, but these effects are not robust when controlling for publication bias (Table 2). Observing initiation anger facial feedback effects would also be more counterintuitive. Unlike happiness, people are generally motivated to avoid feeling angry unless it has an instrumental use (e.g., intimidating a competitor; Kim, Ford, Mauss, & Tamir, 2015; Tamir, 2009; Tamir, Mitchell, & Gross, 2008). In the otherwise neutral contexts created to test initiation facial feedback effects, there are not anger-related instrumental goals. In addition, observing that facial feedback can initiate anger would challenge appraisal theories of emotion (Berkowitz & Harmon-Jones, 2004), which typically conceptualize anger as a response to a blameworthy negative event (Smith & Lazarus, 1993).

Like the combined structure of Studies 1 and 2, Study 3 used a 2 (type of pose: angry or neutral) x 2 (facial feedback task: facial mimicry or voluntary facial action technique) x 2 (stimuli presence: present or absent) design (Figure 6). Participants were run in-person in a laboratory environment and covertly recorded. The experiment was presented through Qualtrics.

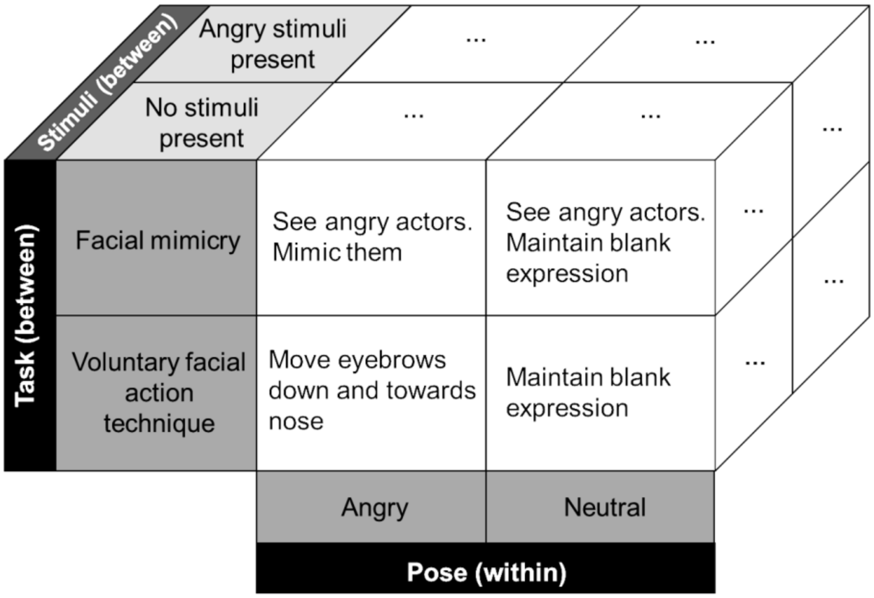

Figure 6. Experimental design of Study 3.

Participants were once again told that the experiment investigated how physical movements and cognitive distractors influence mathematical speed and accuracy. The first, second, and last tasks were filler trials included to ensure the cover story is believable ("Place your left hand behind your head and blink your eyes once per second for 10 seconds", "Touch your right ear with your left hand and hold this position for 10 seconds", and "Tap your left leg with your right-hand index finger once per second for 6 seconds"). In the two critical tasks, participants were asked to pose angry and neutral facial expressions (in randomized order) through either the facial mimicry procedure or the voluntary facial action technique. While posing these expressions, some participants were randomly assigned to view angering images. To reinforce the cover story, participants were provided with an on-screen timer during all tasks.

After each task (including filler tasks), participants completed two randomly-presented simple filler arithmetic problems and a modified version of the Discrete Emotions Questionnaire's anger subscale (C. Harmon-Jones et al., 2016). The original anger subscale asks participants to report the degree to which they felt angry, enraged, mad, and pissed off. Since none of these items capture mild feelings of anger, I asked participants to report how angry, irritated, and annoyed they felt. Pilot testing (reviewed below) indicated that this modified anger subscale had high internal reliability ($\alpha = .98$). Participants also completed two items measuring sadness, four items measuring happiness, one item measuring anxiety, and one question about general negative affect. When answering these questions, participants were asked to report the extent they experienced these feelings during the preceding task.

In the facial mimicry condition, participants were shown a 2 x 2 matrix of actors posing angry expressions. Participants were then instructed to either mimic these expressions (angry condition) or maintain a blank expression (neutral condition). The expression matrix was displayed for at least 5 seconds, and participants indicated when they were ready to perform the mimicry task. In the voluntary facial action technique condition, participants were instructed to either (a) move their brows down and towards their nose using only the muscles in their face (angry condition) or (b) maintain a blank facial posture (neutral condition).

After completing the five movement tasks, participants answered a variety of open-ended questions regarding their beliefs about the purpose of the experiment in a funneled debriefing, wherein they were gradually informed of the true nature of the study. Afterwards, the experimenter rated how aware the participant was of the experimental hypothesis.

Materials

In the facial mimicry conditions, participants viewed a 2 x 2 matrix of models posing angry facial expressions from the Chicago Face Database (Figure 7; Ma, Correll, & Wittenbrink, 2015). A matrix of actor images, as opposed to a single image, was used so that participants had multiple examples of the movement and were provided with more options for a suitable facial model.

Figure 7. Image matrix of actors posing angry expressions shown to participants in the Study 3 mimicry conditions. Participants were instructed to either mimic these faces or maintain a blank pose.

Selection of angry images.

During the two critical posing tasks, one group of participants viewed an array of four angering images. These images were selected based on the results of a pilot test. More specifically, based on Internet searches, I selected 12 images I believed would be perceived as angering (e.g., an image of a theft), 12 images I believed would be perceived as sad (e.g., an image of a burning school bus), and 12 images I believed would be perceived as relatively neutral (e.g., an image of a chair). Thirty-one participants viewed these images in random order and either rated how angry (n = 11), sad (n = 10), or disgusted (n = 10) each image made them feel using the Discrete Emotions Questionnaire (C. Harmon-Jones et al., 2016). The original anger subscale asks participants to report how angry, enraged, mad, and pissed off they feel. However, to capture milder forms of anger, I asked participants to report how angry, irritated, aggravated and annoyed they felt. To summarize, this pilot study used a 3 (image type: angry, sad, neutral) x 3 (rating: angry, sad, disgusted) design, with image type manipulated within-participants and rating manipulated between-subject.

To examine whether participants reported feeling more angry after viewing angering vs. neutral and sad photos, anger ratings were modeled using linear mixed-effects modeling with image type entered as a factor and random-intercepts. Results confirmed that anger ratings varied by image type, $F(2, 383) = 283.76$, $p < .001$. Follow-up least-squares pairwise comparisons indicated that participants reported feeling more angry after viewing angry ($M = 4.38$, $SD = 1.39$) vs. neutral images ($M = 1.25$, $SD = 0.70$, $M_{\text{diff}} = 3.13$, 95% CI [2.85, 3.42], $p < .001$). Surprisingly, participants only reported feeling slightly more angry after viewing angry vs. sad images ($M = 4.13$, $SD = 1.79$, $M_{\text{diff}} = 0.25$, 95% CI [-0.04, 0.54], $p = .09$). Participants provided surprisingly high ratings of anger after viewing sad images, which indicates that sad images (e.g., images of starving dogs, injured soldiers, and sick children) may have created blended feelings of sadness and anger.

To examine whether participants who viewed angry photos reported stronger feelings of anger vs. sadness and disgust, I calculated emotional intensity values by taking the absolute value of anger, sadness, or disgust ratings. Next, emotional intensity ratings were modeled using linear mixed-effects modeling with type of rating entered as a factor and random-intercepts. Results indicated that emotional intensity varied by type of rating, $F(2, 28) = 25.92$, $p < .001$. Follow-up least-squares pairwise comparisons indicated that angry photos made participants feel more angry ($M = 4.38$, $SD = 1.39$) than sad ($M = 2.32$, $SD = 1.15$, $M_{diff} = 2.06$, 95% CI [1.40, 2.72], $p < .001$) and disgusted ($M = 2.48$, $SD = 1.52$, $M_{diff} = 1.91$, 95% CI [1.25, 2.56], $p < .001$). These analyses indicate that, although angering images primarily evoke feelings of anger, they also evoke feelings of sadness and disgust. To enable cleaner inferences about whether scowling can modulate feelings of anger, I chose angry stimuli that elicited the largest difference in anger and sadness ratings. To do so, for each stimulus, I calculated the mean difference in angry and sadness scores and chose stimuli with the largest mean differences. The final set of stimuli is presented in Figure 8.

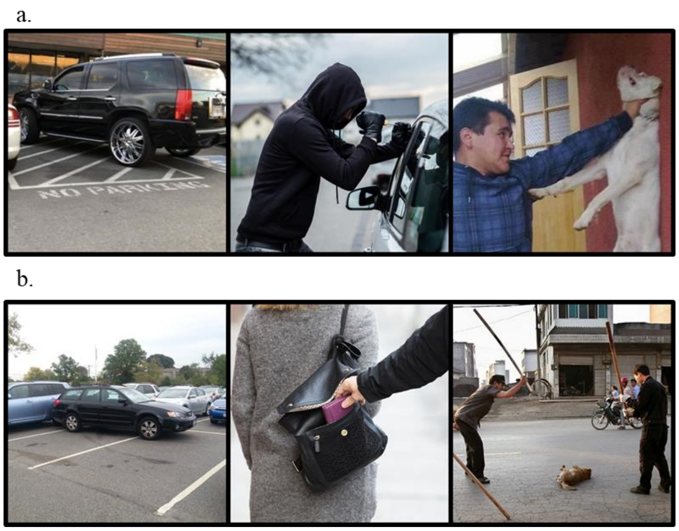

Figure 8. Images shown to Study 3 participants in the condition testing whether posing angry expressions can modulate feelings of anger. One set of images (either a or b) were shown during the angry pose trials and the other was shown during the neutral pose trials (counterbalanced).

Results

To examine whether facial feedback impacted self-reported anger, a 2 (type of pose: angry or neutral) x 2 (facial feedback task: facial mimicry or voluntary facial action technique) x 2 (stimuli presence: absent or present) linear mixed-effect regression was fitted with pose, task, and stimuli presence entered as effects-coded factors and random-intercepts for each participant.

Consistent with the facial feedback hypothesis, participants reported more anger after posing angry (M = 1.66, SD = 0.97) vs. neutral expressions (M = 1.50, SD = 1.02), $F(1, 198) = 6.55$, $p = .01$. No main effect for facial feedback task was detected, $F(1, 198) = 1.62$, $p = .20$. There was also a main effect for stimuli presence, wherein participants reported more anger when angering stimuli were present (M = 1.79, SD = 1.19) vs. absent (M = 1.34, SD = 0.63), $F(1, 198) = 12.28$, $p < .001$.

Results also revealed an interaction between pose and stimuli presence, $F(1, 198) = 4.04$, $p = .046$. Surprisingly, follow-up contrasts indicated that there was significant evidence of a facial feedback effect when stimuli were absent ($F(1, 198) = 9.69$, $p = .002$) but not when stimuli were present, $F(1, 198) = 0.16$, $p = .69$ (Figure 9). These findings provide evidence that scowling can initiate, but not modulate, feelings of anger.

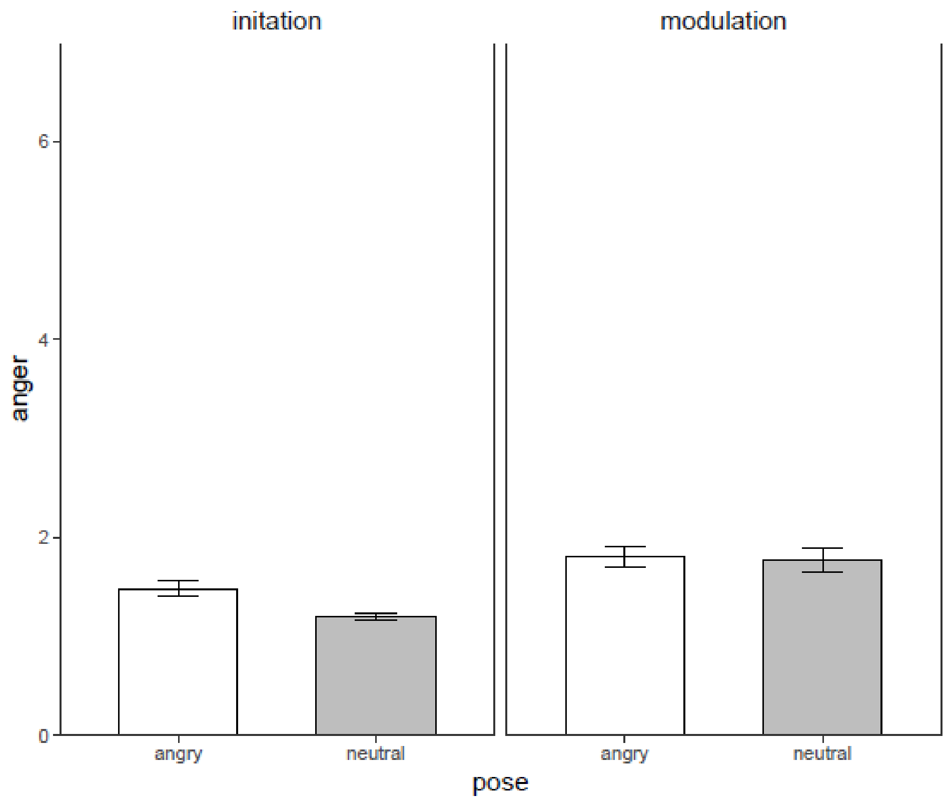

Figure 9. Anger reports after posing angry and neutral expressions while angering stimuli were absent (initiation) and present (modulation) in Study 3.

Participant awareness.

Based on in-person funnel debriefing responses, experimenters rated the degree to which participants were aware of the purpose of the experiment (0 = "not at all aware" to 4 = "completely aware"). Results indicated that participants generally exhibited low awareness of the purpose of the experiment (*M* = 0.52, *SD* = 0.97), with 87% of participants characterized as not at all or slightly aware. To examine whether participant awareness varied across conditions, awareness ratings were modeled using a 2 (facial feedback task: facial mimicry or voluntary facial action technique) x 2 (stimuli presence: present or absent) ANOVA. Results did not indicate that participants were more aware of the purpose of the experiment in the facial mimicry (*M* = 0.52, *SD* = 0.92) vs. voluntary facial action technique (*M* = 0.52, *SD* = 1.02) condition (*F*(1, 198) = 0.00, *p* = .95) or when emotional stimuli were present (*M* = 0.59, *SD* = 1.00) vs. absent (*M* = 0.44, *SD* = 0.93), *F*(1, 198) = 1.14, *p* = .29. No interaction between awareness and stimuli presence was detected, *F*(1, 198) = 0.06, *p* = .80.

Although this study provides evidence in favor of the facial feedback hypothesis, it is possible that these effects were driven by participants' awareness of the purpose of the experiment. When the confirmatory analyses were re-run with participant awareness included as a moderator, results did not provide significant evidence that facial feedback effects are larger when participants are more aware of the purpose of the experiment, *F*(1, 194) = 0.68, *p* = .41. Furthermore, the patterns of confirmatory results were identical when controlling for awareness of the facial feedback hypothesis (Pose main effect: *F*(1, 194) = 3.29, *p* = .07; Task main effect: *F*(1, 194) = 0.27, *p* = .60; Stimuli presence main effect; *F*(1, 194) = 10.98, *p* = .001; Pose by stimuli presence interaction: *F*(1, 194) = 4.37, *p* = .04). Taken together, these results indicate that awareness of the purpose of the experiment does not fully account for these results.

Prototypicality of posed expressions.

For participants who consented for their videos to be analyzed (n = 187), video recordings of their neutral and angry posing trials were processed through Noldus' FaceReader 7.0, which provided moment-to-moment ratings of expressed anger (0 to 1; Lewinski, den Uyl, & Butler, 2014). FaceReader failed to code videos from 14 participants, leaving a final sample of 173 pairs of videos.

Expressed anger ratings were modeled using a 2 (type of pose: angry or neutral) x 2 (facial feedback task: facial mimicry or voluntary facial action technique) x 2 (stimuli presence: absent or present) mixed-effect ANOVA, with type of pose included as a within-participant factor. As expected, participants expressed more anger during the angry (M = .22, SD = .29) vs. neutral (M = .06, SD = .16) trials, $F(1, 169) = 45.64$, $p < .001$. Unexpectedly, results did not indicate that participants expressed more anger in the facial mimicry (M = .15, SD = .26) vs. voluntary facial action technique (M = .13, SD = .23) condition, $F(1, 169) = 1.65$, $p = .20$. This suggests that the manipulation of the prototypicality of posed expressions of anger was ineffective. As expected, participants expressed more anger when angering stimuli were present (M = .19, SD = .29) vs. absent (M = .08, SD = .18), $F(1, 169) = 5.78$, $p = .02$. No higher-order interactions were significant (all ps > .16).

Exploratory analyses.

Although outside the original scope of the project, I also tested the effects of scowling on feelings of sadness, happiness, and negativity. According to basic emotion theories (Izard, 1971; Tomkins, 1962), angry poses should have emotion-specific effects on emotional experience. That is, scowling should increase feelings of anger, but not affect feelings of sadness or happiness. However, according to constructionist theories of emotion (Barrett, Wilson-Mendenhall, &

Barsalou, 2014; Lindquist, 2013), angry poses should not only increase feelings of anger, but also increase other negative-valenced emotions (e.g., sadness and negativity) and decrease positive-valenced emotions (e.g., happiness).

To examine these competing predictions, sadness, happiness, and negativity ratings were modeled using 2 (type of pose: angry or neutral) x 2 (facial feedback task: facial mimicry or voluntary facial action technique) x 2 (stimuli presence: absent or present) linear mixed-effect regressions with pose, task, and stimuli presence entered as effects-coded factors and random-intercepts for each participant. Surprisingly, results provided marginal evidence that participants reported *lower* levels of sadness after posing angry (M = 1.28, SD = 0.82) vs. neutral expressions (M = 1.39, SD = 0.88), $F(1, 198) = 3.11$, $p = .08$. Results did not indicate that participants reported lower levels of happiness after posing angry (M = 1.38, SD = 0.91) vs. neutral expressions (M = 1.40, SD = 0.89), $F(1, 198) = 0.84$, $p = .36$. However, results did provide marginal evidence that participants reported higher levels of negativity after posing angry (M = 1.83, SD = 1.31) vs. neutral expressions (M = 1.71, SD = 1.23), $F(1, 198) = 2.47$, $p = .12$. These results are inconsistent with constructionist theories of emotion, which predict that scowling would (a) increase sadness and negativity and (b) decrease happiness. Consequently, I suggest that these results are more consistent with basic theories of emotion, which correctly predicted an emotion-specific effect of scowling on anger.

Discussion

Results indicate that (1) posing angry facial expressions can initiate feelings of anger and (2) this effect is not fully accounted for by awareness of the purpose of the experiment. Surprisingly, results did not indicate that posing angry facial expressions can modulate feelings of anger. One explanation for this pattern of results is that participants had to suppress an angry expression in order to maintain a neutral expression while looking at angering photos. Expression suppression often causes increases in negative affect (Gross, 2002; Gross & Levenson, 1997), which could have masked a true modulating anger facial feedback effect. To examine this possibility, future research can examine self-reported anger when participants have suppressed, uninhibited, or exaggerated expressions while viewing angering photos.

Chapter 6: General Discussion and Conclusion

Results from Studies 1-3 studies indicate that posing happy facial expressions can both initiate and modulate feelings of happiness. Furthermore, results indicate that posing angry expressions can initiate feelings of anger. Importantly, these effects do not seem to be driven by demand characteristics; Facial feedback remained robust even after controlling for experimenters' ratings of participant awareness.

One limitation of Studies 1-3 is that inferences about demand characteristics are only as valid as experimenters' ratings of participant awareness. Some participants may have not been willing or able to articulate their beliefs about the experiment. Furthermore, experimenters may not have been able to make accurate judgments about participants' beliefs. To address this limitation, I manipulated participants' beliefs about the study hypothesis in a study not discussed in this dissertation. Researchers either (a) told participants that they hypothesized their facial poses would influence their emotions, (b) told participants that they hypothesized their facial poses would *not* influence their emotions, or (c) provided participants with no information about their hypothesis. Afterwards, participants posed happy, angry, and neutral expressions in otherwise non-emotional contexts. Preliminary results suggest that posing happy expressions can initiate feelings of happiness and posing angry expressions can initiate feelings of anger even when participants are told these effects are not real. This provides further evidence that facial feedback effects are not wholly driven by demand characteristics.

The Facial Feedback Component Process Framework

Now that there is evidence that facial feedback *can* influence emotion, researchers are left with a more difficult question: How do these effects work? Thus far, theorists have provided seemingly disparate explanations regarding how facial feedback influences emotion. These explanations can be categorized into four themes, the effects of facial feedback on:

1. Emotional experience (the focus of this research; Allport, 1922; Izard, 1977, 2007; Laird, 1974; McIntosh, Zajonc, Vig, & Emerick, 1997; Schnall & Laird, 2003; Tomkins, 1962; Zajonc, 1985).
2. The cognitive processing of emotional information (Forster and Strack, 1996; Niedenthal et al., 2005; Scherer, 2009; Schnall and Laird, 2003; Smith and Kirby, 2004; Strack et al., 1988; Wood et al., 2016).
3. Motivational states/behavior (Coan, Allen, & Harmon-Jones, 2001; E. Harmon-Jones, Gable, & Price, 2011; Wansink, Zampollo, Camps, & Shimizu, 2014).
4. Autonomic nervous system (ANS) activity (Ekman, Levenson, & Friesen, 1983; Kraft & Pressman, 2012; Levenson, Carstensen, Friesen, & Ekman, 1991; Levenson et al., 1990, 1992; Pressman, Bhakta, Khuu, & Ontiveros, 2014; Pressman, Kraft, Acevedo, & Chagany, 2014).

Although existing theories tend to emphasize a single effect of facial feedback on emotion, they do not typically exclude the possibility that facial feedback can have *multiple* effects on emotion (Table 3). For example, Levenson and colleagues have focused on the effects of facial feedback on ANS activity (Ekman et al., 1983; Levenson et al., 1991, 1990, 1992). However, Levenson and colleagues agree with (a) Harmon-Jones' assertion that facial feedback exerts a separate effect on motivational states (Ekman, 1979; Ekman & Davidson, 1993; Levenson et al., 1990), and (b) Allport, Laird, Izard, Tomkins, and Zajonc's assertions that facial feedback influences emotional experience (Ekman, 1979, 1993; Ekman & O'Sullivan, 1991; Frank & Ekman, 1996; Levenson et al., 1990, 1992). Yet, researchers currently lack a comprehensive framework that integrates the *multiple* ways that facial feedback might influence emotion. A comprehensive framework could (a) conceptually organize overlapping but often disconnected lines of research, (b) facilitate discussions about various ways that facial feedback may influence emotion, and (c) unite facial feedback researchers under a common framework. As a candidate for this framework, I present the Facial Feedback Component Process Framework (ffCPF; Figure 10).

Table 3. Facial feedback effects predicted by various theories.

Theorist	Cognitive appraisal	Action tendencies	ANS activity	Emotional experience
Laird: Self-attribution theory of emotion (Duclos & Laird, 2001; Duclos et al., 1989; Duncan & Laird, 1977; Flack, Laird, & Cavallaro, 1999b, 1999a; Laird, 1974, 1984; Laird & Bresler, 1992; Laird & Crosby, 1974; Laird & Strout, 2007; Schnall & Laird, 2003, 2007)	yes	-	-	yes
Strack: Direct proprioception hypothesis (Förster & Strack, 1996; Martin et al., 1992; Stepper & Strack, 1993; Strack et al., 1988; Strack & Neumann, 2000)	yes	-	-	yes
Zajonc: Vascular theory of emotional efference (Berridge & Zajonc, 1991; McIntosh et al., 1997; Zajonc, 1985; Zajonc & McIntosh, 1992; Zajonc, Murphy, & Inglehart, 1989; Zajonc, Murphy, & McIntosh, 1993)	-	yes	yes	yes
Ekman: Affect program theory (Ekman, 1979, 1993; Ekman & Davidson, 1993; Ekman et al., 1983; Ekman & O'Sullivan, 1991; Frank & Ekman, 1996; Levenson et al., 1991, 1990, 1992)	-	yes	yes	yes
Izard: Differential emotion theory (Izard, 1977, 1981, 1990, 1993, 2007; Tomkins, 1962)	yes	yes	-	yes

Table 3 Continued. Facial feedback effects predicted by various theories.

Theorist	Cognitive appraisal	Action tendencies	ANS activity	Emotional experience
Allport: Physiological-genetic theory of feeling and emotion (Allport, 1922, 1924)	-	-	-	yes
Harmon-Jones: Motivational facial feedback hypothesis (Coan et al., 2001; E. Harmon-Jones et al., 2011; E. Harmon-Jones & Peterson, 2009; Price & Harmon-Jones, 2010; Price, Hortensius, & Harmon-Jones, 2013; Price, Peterson, & Harmon-Jones, 2012)	-	yes	yes	yes

Note. Highlighted cells indicate primary focus of the theory.

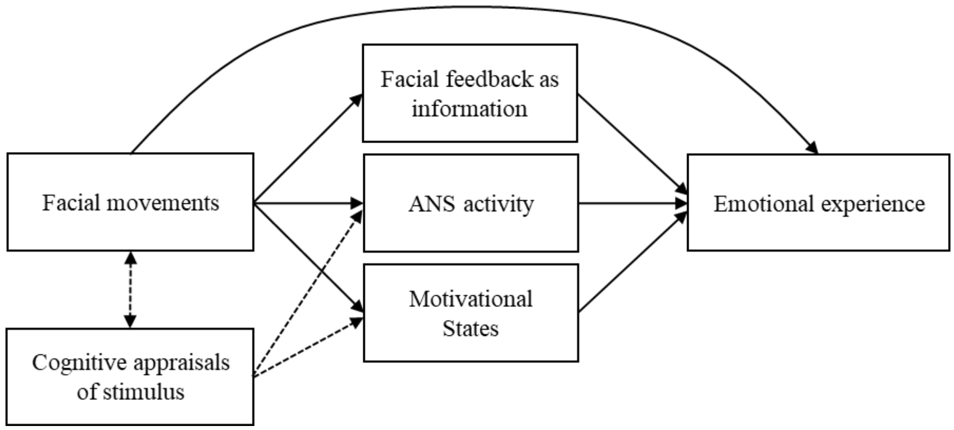

Figure 10. The Facial Feedback Component Process Framework. Filled lines highlight potential mechanisms when no emotional stimuli are present. Dotted lines highlight additional potential mechanisms when emotional stimuli are present.

The ffCPF is a framework—not a theory—designed to provide an exhaustive list of potential facial feedback mechanisms. Building off embodied cognition theories, the ffCPF raises the possibility that emotion-related knowledge is stored in networks of multimodal representations that contain information about associated cognitions, motivational states/behaviors, facial expressions, other bodily states, and evaluations (Barsalou, 2008; Niedenthal et al., 2005; Wilson-Mendenhall, Barrett, & Barsalou, 2012; Wood et al., 2016). If true, the activation of one component of the network should partially activate its other representations. Consequently, posing a facial expression of happiness should activate associated appraisals (e.g., evaluations of goal-conduciveness), actions (e.g., tendencies to approach), other emotion-related bodily states (e.g., ANS activity), and evaluations (e.g., that things are going well). Following Schwarz and Clore's (1983) concept of *affect as information*, I refer to these evaluations as *facial feedback as information*. Notably, the ffCPF uses this embodied cognition framework to provide a mechanistic account that can accommodate the four types of facial feedback effects discussed by previous theorists. However, other mechanisms (e.g., innate connections between facial expressions and ANS activity) are also plausible.

Like appraisal theories of emotion, the ffCPF is consistent with the idea that (a) emotional events often begin with the cognitive appraisals of a stimulus, and (b) facial expressions are often the influenced by cognitive appraisals (Moors, Ellsworth, Scherer, & Frijda, 2013; Roseman & Smith, 2001; Scherer, 1984a, 1984b, 2009; Scherer & Moors, 2019). However, unlike appraisal theories of emotion, the ffCPF raises the possibility that cognitive appraisals may not be a necessary antecedent of emotional experience (e.g., that facial feedback can initiate feelings of happiness and anger in otherwise neutral contexts).

Future Directions

The ffCPF is designed to provide an exhaustive list of potential mechanisms in order to provide a unifying framework for studying the effects of facial feedback on emotion. However, future research should critically evaluate which—if any—of the effects included in the framework are valid.

Testing the effects of facial feedback on non-experiential aspects of emotion.

This dissertation provided strong evidence that facial feedback can influence emotional experience. However, as shown in the ffCPF, other researchers have suggested that facial feedback also influences non-experiential components of emotion (i.e., cognitive appraisals, ANS activity, motivation states). To evaluate these possibilities, researchers must identify and then manipulate the facial movements associated with these non-experiential components of emotion. When unknown, researchers can measure participants' beliefs about these associations. For example, participants could be shown computer-generated images of models displaying a variety of emotional facial expressions (e.g., happiness, sadness, fear) and then asked to rate the degree to which the model (1) engaged in a variety of cognitive appraisals (e.g., judged their situation to be pleasant), (2) is experiencing a variety of motivations, and (3) is experiencing a variety of changes in physiological activity (e.g., heart rate). Unlike socially sensitive associations (e.g., racial attitudes), participants are probably not motivated to mask their true beliefs about associations between facial movements and emotion. Therefore, these associations should be able to be assessed with explicit, as opposed to implicit, measures of associations (Fazio & Towles-Schwen, 1999).

To date, evidence that facial feedback can influence cognitive appraisals, ANS activity, and/or motivational states is either preliminary or mixed. This evidence is reviewed below.

Effects of facial feedback on cognitive appraisals.

In perhaps the only direct test of the effects of facial feedback on cognitive appraisals, Keltner, Ellsworth, and Edwards (1993) asked participants to pose angry or sad expressions and subsequently rate the degree to which future events were controllable (an appraisal positively associated with feelings of anger and negatively associated with feelings of sadness). Consistent with the idea that facial feedback influences cognitive appraisals, results indicated that participants rated future events as more controllable when posing angry vs. sad expressions. However, future research should examine whether these findings are replicable, especially since the sample size was small (n = 17 per condition). In addition, future research should examine whether these findings are generalizable to other cognitive appraisals, such as appraisals of uncertainty and perceived effort. For example, perhaps posing expressions of fear lead to increased appraisals of uncertainty and posing expressions of sadness lead to increased appraisals of perceived effort.

Rather than manipulate full facial expressions, researchers may choose to manipulate specific facial movements associated with appraisals (Scherer, Mortillaro, Rotondi, Sergi, & Trznadel, 2018). For example, using the Facial Action Coding System (Ekman & Rosenberg, 1997), Scherer and colleagues (2018) identified specific facial movements associated with a variety of appraisals, such as suddenness (AUs 1, 2, 5, and 26) and goal conduciveness (AUs 5, 6, 12, 25, and 27). If these associations are valid, appraisals of suddenness and goal conduciveness might be facilitated when their associated action units are activated.

Effects of facial feedback on motivational states.

Evidence that facial feedback influences approach- and avoidance-related motivational states is mixed. Most research examining the effects of facial feedback on motivational states has used frontal EEG asymmetry as an index of motivation. More specifically, Coan and colleagues suggest that greater right hemispheric activation is an index of motivation to withdraw and greater left hemispheric activation is an index of motivation to approach (Coan & Allen, 2004; Coan, Allen, & Harmon-Jones, 1999; but see Palmiero & Piccardi, 2017). Following this framework, the ffCPF raises the possibility that (1) withdrawal-associated expressions (e.g., pouts) will lead to relatively greater right hemispheric activation and (2) approach-associated facial expressions (e.g., smiles) will lead to relatively greater left hemispheric activation. To examine this, Coan and colleagues (2001) measured frontal EEG while participants followed muscle-by-muscle facial expression instructions. Their results indicated that withdrawal-associated expressions led to relatively greater right hemispheric activation. However, their results did not indicate that approach-associated expressions led to relatively greater left hemispheric activation. A similar pattern of results was uncovered by Price and colleagues (2013), who also failed to find that facial feedback influenced a behavioral measure of motivational states, persistence on an insolvable task.

Effects of facial feedback on ANS activity.

Evidence that facial feedback influences ANS activity is also mixed. Using a similar method as Coan et al. (2001), Levenson and colleagues found that facial feedback led to emotion-specific patterns of ANS activity, such as changes in heart rate and skin conductance (Levenson et al., 1991, 1990, 1992). However, their findings are characterized by some inconsistencies. For example, Levenson et al. (1990) found that participants have higher heart rates when posing fearful expressions than when posing sad expressions. However, two later studies provide results that trended in the opposite direction (Levenson et al., 1991, 1992).

To summarize, following predictions from other theorists (Table 3), the ffCPF raises the possibility that facial feedback influences cognitive appraisals, ANS activity, and/or motivational states. However, evidence that facial feedback influences these non-experiential components of emotion is either preliminary or mixed. One possibility is that facial feedback only influences emotional experience. This would be consistent with recent developments in the *power posing* literature: a conceptually similar literature on the effects of expansive full-body postures on felt power. Originally, Carney, Cuddy, and Yap (2010) suggested that expansive postures increased both subjective and physiological measures of felt power. However, nearly a decade later, most researchers have concluded that power posing only influences subjective measures of power (Jonas et al., 2017). Future research will reveal whether a similar fate awaits the facial feedback literature.

Testing embodied associations as moderators of facial feedback effects.

Following embodied cognition theories, one possibility is that the effects of facial feedback on emotional experience, cognitive appraisals, motivational states, and/or ANS activity are moderated by embodied associations. This proposed moderator can be tested using both correlational and experimental approaches. To study the proposed moderator using correlational approaches, researchers can study the effects of posing culture-specific emotional expressions on emotion. For example, in the Oriya Hindu culture, *Kali's tongue* is a culturally-unique facial expression of shame wherein people protrude and bite their tongue between their lips (Memon & Shweder, 1994). If facial feedback effects are driven by embodied associations, posing Kali's tongue should produce feelings of shame for individuals in the Oriya Hindu population, but not people in most other populations. Furthermore, if these effects are driven by embodied associations, the effects of posing Kali's tongue on shame should be moderated by the strength of the embodied association. Consequently, these effects may be stronger for individuals within the Oriya Hindu population who are more familiar with the *Kali's tongue* expression.

Researchers could also use experimental approaches to examine whether facial feedback effects are moderated by embodied associations. One approach is to (1) create a novel association between a facial movement and an emotional state, and (2) subsequently test whether the emotional state can be re-activated by the facial movement. For example, researchers could ask participants to puff their cheeks while they view happy images and suck in their cheeks while they view sad images. This task should create a novel association between the facial movements and emotion. After completing this task dozens of times, participants could be asked to puff or suck in their cheeks and subsequently report how they feel. If facial feedback effects are driven by embodied associations, participants should report feeling happier when puffing their cheeks and sadder when sucking in their cheeks.

Other Implications of Facial Feedback Research

Evidence that facial feedback can initiate emotional feelings in otherwise neutral contexts suggests that facial feedback may be a useful emotion elicitation procedure (Laird & Strout, 2007). This procedure may contribute to theoretical progress on other outstanding theoretical debates in the affective sciences. For example, researchers have long debated whether feelings of happiness and sadness can co-occur (Larsen & McGraw, 2011; Larsen & Mcgraw, 2014; Russell, 1980; Russell & Carroll, 1999). People sometimes report feeling mixed emotions of happiness and sadness when, for example, watching bittersweet films or experiencing conflicting goals (Larsen, Coles, & Jordan, 2017; Larsen, McGraw, & Cacioppo, 2001). However, one alternative explanation is that people do not *feel* happy and sad at the same time, but rather recognize that the situation has both happy and sad connotations (Larsen, 2017; Russell, 2017). In one study under development, I plan to address this alternative explanation by examining whether posing mixed facial expressions of happiness and sadness can initiate mixed feelings[3]. If mixed facial feedback can initiate mixed feelings in otherwise neutral contexts, this would provide compelling evidence against the claim that people only report mixed emotions because they recognize that the situation is both positive and negative.

At first glance, evidence that facial feedback influences emotion seemingly supports claims that facial feedback interventions—for example, smiling more or frowning less—can help manage distress (Ansfield, 2007; Kraft & Pressman, 2012), improve well-being (Lyubomirsky, 2008; Schmitz, 2016), and reduce depression (Alam, Barrett, Hodapp, & Arndt, 2008; Alves, Sobreira, Aleixo, & Oliveira, 2016; Chugh, Chhabria, Jung, Kruger, & Wollmer, 2018; Finzi, 2013, 2018; Finzi & Rosenthal, 2014, 2016; Finzi & Wasserman, 2006; Fromage, 2018; Hexsel et al., 2013; Lewis & Bowler, 2009; Magid et al., 2015, 2014; Magid & Reichenberg, 2015; Parsaik et al., 2016; Reichenberg et al., 2016; Wollmer et al., 2012; Wollmer, Kalak, et al., 2014; Wollmer, Magid, & Kruger, 2014; Zamanian, Jolfaei, Mehran, & Azizian, 2017). However, all available evidence suggests that facial feedback effects are extremely small—perhaps too small to have a noticeable impact on well-being (Coles, Larsen, Kuribayashi, & Kuelz, 2019; Coles, Larsen, & Lench, 2019). Nevertheless, optimistic researchers can examine this possibility via a longitudinal smiling intervention.

Conclusion

This dissertation is being completed in a period of high emotions: the COVID-19 global pandemic. The exponentially rising number of deaths and documented cases of COVID-19 have left many feeling scared. The increasing need to social distance and/or quarantine has left many

[3] Early in my graduate career, examining whether posing mixed facial expressions can initiate mixed feelings was the impetus for studying facial feedback effects.

feeling lonely. And the resiliency and determination of the human race has left many feeling awestruck and optimistic. How might our future look different if we were unable to experience that fear, that loneliness, or that optimism? And—more fundamentally—what are the processes that allow us to experience such powerful emotions?

Most modern theories of emotion posit that emotional experience is built from signals from the peripheral nervous system (Cacioppo et al., 1992; Damasio & Carvalho, 2013; Laird & Bresler, 1992; Lange, 1885; Levenson et al., 1990; Russell, 1980; Scherer & Moors, 2019; Tomkins, 1962; Wood et al., 2016). However, decades of research have failed to elucidate the precise relationship between the peripheral nervous system and emotional experience. One reason is that most components of the peripheral nervous system are *emotionally undifferentiated*, meaning that it is difficult to distinguish between different discrete emotions (e.g., happiness and fear) by looking at only a single component (e.g., heart rate; Siegel et al., 2018). Discrete emotions are, however, more distinguishable by facial expressions, and results from this dissertation suggest that facial feedback has emotion-specific effects on experience. Combined with the ease and precision at which facial feedback can be manipulated, these results suggest that the face might be a particularly effective approach to studying the relationship between the peripheral nervous system and emotional experience.

The ffCPF provides an integrative framework for studying the role of facial feedback in emotion. Future research can use the ffCPF as a starting point for developing more precise models of the role of facial feedback in emotion. Once these models are developed, researchers can use these models to guide inquiries about the role of less experimentally amenable components of the peripheral nervous system, such as heart rate. Together, these complementary lines of research can help illuminate the inner workings of one of the most profound human senses: emotional experience.

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Vita

Nicholas Alvaro Coles was raised in Longwood, FL, where he attended Highlands Elementary School, Greenwood Lakes Middle School, and Lake Mary High School, graduating in 2011. He subsequently attended the University of Central Florida, where he began researching emotion at the Institute of Simulation and Training, the Applied Cognition and Technology Lab, and the UCF Medical School. He completed an undergraduate thesis titled *A Psychophysiological Investigation of the Paradoxical Effects of Valuing Happiness* under the supervision of Dr. Valerie Sims. In 2015, he received a Bachelor of Science degree in Interdisciplinary Studies, with multiple distinctions.

Nicholas joined the Psychology Department at the University of Tennessee-Knoxville in 2015, where he conducted research on emotion and meta-science under the supervision of Drs. Jeff Larsen and Lowell Gaertner. From 2016-2020 he was a National Science Foundation Graduate Research Fellow, and from 2018-2019 he was a National Science Foundation Visiting Research Fellow at the Eindhoven University of Technology (under the direction of Daniël Lakens). Nicholas graduated with a Masters of Arts in Psychology in December 2017, with a thesis titled *A Meta-Analysis of the Facial Feedback Literature: Effects of Facial Expressions on Emotional Experience are Small and Variable*. Nicholas graduated with a Doctor of Philosophy in Psychology in May 2020 and subsequently joined Harvard University as a post-doctoral research fellow.