Interrupting Holistic Processing May Improve the Detection of Deceptive Emotional Facial Expressions

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Abstract
Although a growing body of evidence suggests that genuine and deceptive facial expressions differ, previous work is mixed as to whether observers can discern between them. One explanation is that cues to deception on the face are subtle and not readily perceived by observers. I argue that the way people process faces may obscure these cues, making them ‘unseen’ by observers. In the current work, I pit two hypotheses against each other to test whether interrupting holistic processing improves or impairs the ability to identify deceptive emotional expressions. Since people process faces holistically, one region of the face may interfere with or bias observers’ perception of other regions. Importantly, however, interrupting holistic processing by misaligning faces allows people to more accurately detect emotion expressed in one region with less interference from other regions of the face. Since deceptive expressions involve partial expressions wherein felt emotion ‘leaks out’ in the upper or lower face only, I suggest that interrupting holistic processing will increase observers’ ability to identify the incongruence among the face halves. Alternatively, it is possible that the subjective disfluency experienced when viewing incongruent expressions could be used as a cue to deception, suggesting that holistic processing would facilitate the detection of incongruence. Three studies test these competing hypotheses by asking observers to rate the genuineness of facial expressions that were artificially produced (Pilot Study, Study 1) or real and posed (Study 2). Holistic processing was interrupted by horizontally misaligning faces. Across all studies, the subjective disfluency hypothesis was not supported. Instead, observers rated incongruent (Pilot Study, Study 1) and posed (Study 2) expressions as less genuine when holistic processing was interrupted with misalignment (vs. aligned faces). This interpretation, however, is complicated by the findings for congruent (Study 1) and genuine (Study 2) expressions, wherein misaligned faces were rated as less genuine than aligned faces. Future research should continue to consider how people visually process faces and its impact on veracity judgments. By borrowing insights from vision science, we may better understand factors affecting observers’ ability to detect genuine (vs. deceptive) facial expressions.

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Although a growing body of evidence suggests that genuine and deceptive facial expressions differ, previous work is mixed as to whether observers can discern between them. One explanation is that cues to deception on the face are subtle and not readily perceived by observers. I argue that the way people process faces may obscure these cues, making them ‘unseen’ by observers. In the current work, I pit two hypotheses against each other to test whether interrupting holistic processing improves or impairs the ability to identify deceptive emotional expressions. Since people process faces holistically, one region of the face may interfere with or bias observers’ perception of other regions. Importantly, however, interrupting holistic processing by misaligning faces allows people to more accurately detect emotion expressed in one region with less interference from other regions of the face. Since deceptive expressions involve partial expressions wherein felt emotion ‘leaks out’ in the upper or lower face only, I suggest that interrupting holistic processing will increase observers’ ability to identify the incongruence among the face halves. Alternatively, it is possible that the subjective disfluency experienced when viewing incongruent expressions could be used as a cue to deception, suggesting that holistic processing would facilitate the detection of incongruence. Three studies test these competing hypotheses by asking observers to rate the genuineness of facial expressions that were artificially produced (Pilot Study, Study 1) or real and posed (Study 2). Holistic processing was interrupted by horizontally
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Chapter One

People often lie—on average, in one of every four social interactions per day (DePaulo et al., 1996). While many of these lies are harmless and socially appropriate, ‘big’ lies can have dramatic consequences if undetected (Ekman, 2009; Vrij, 2008). For example, lies told by perpetrators or witnesses of crimes are of grave concern to law enforcement, as identifying (or misidentifying) lies in this context can have serious consequences for the pursuit of justice and public safety (Kassin et al., 2010). Depending on the context, these lies may be aided by acts of emotional deception wherein genuine emotional expressions are suppressed, false emotional expressions are simulated, or both (e.g., ten Brinke & Porter, 2012). However, behavioral cues to deception in general, and cues to deceptive emotional expressions specifically, are subtle (e.g., DePaulo et al., 2003; Ekman et al., 1981; Hurley & Frank, 2011; Porter & ten Brinke, 2008), and people perform poorly at discriminating liars from truth-tellers (e.g., Bond & DePaulo, 2006; Evanoff et al., 2016; Stel & van Dijk, 2018; Zloteanu et al., 2019). Accordingly, some scholars have suggested that accuracy could be improved if behavioral cues to deception were actively exacerbated, making them easier to perceive and incorporate into decisions about veracity (Hartwig & Bond, 2011; Vrij et al., 2008; Vrij & Mann, 2004).

I build upon this explanation to suggest that visual perception plays an important role in deception detection and that greater consideration of the visual processing of faces may help to explain why subtle cues are not used by observers to make more accurate
truth–lie judgments. Specifically, I borrow insights from the vision science literature on how we process faces to suggest that interrupting holistic processing of faces may increase sensitivity to deception cues of emotional facial expressions.

**Emotional Facial Expressions**

Darwin (1872) proposed that universal facial expressions of emotion have evolved in a process where specific facial movements served a biologically adaptive function for the sender and the observer and, over a long period of time, become innately associated with signaling emotion. He described these expressions as ‘serviceable habits’ where particular movements of the face prepared the sender for perception and action, and for observers, these movements came to communicate emotional states. Although there is considerable debate about the universality of human emotional facial expressions, Ekman and colleagues purported to have identified basic emotional expressions of happiness, sadness, anger, fear, surprise, and disgust (Ekman, 1971; Ekman & Friesen, 1971; Matsumoto, 1992; Rosenberg & Ekman, 1995). In this view, emotions are reliably expressed in the form of specific morphological changes in facial musculature, and observers can accurately decode these movements to infer expressers’ emotional states (Ekman, 1992; Ekman & Cordaro, 2011; Levenson, 2011). Evidence for the universality of these expressions comes from research that supports the consistent production and recognition of these basic emotions cross-culturally, including among indigenous groups who had no or limited contact with Western influences (Cowen & Keltner, 2020; Ekman et al., 1969, 1972; Ekman & Friesen, 1971; Izard, 1994; Matsumoto et al., 2008).

Other researchers, however, have disagreed with the notion of basic universal emotions, suggesting that some semantic categories are not pancultural, that emotions
cannot always be inferred from facial expressions, and that there is significant heterogeneity in the way each of the basic emotions is conveyed (e.g., Barrett et al., 2019; Russell, 1995). Despite the continuing controversy surrounding the production of emotional facial expressions and their relation to felt emotions, when presented with prototypical expressions of so-called basic emotions, observers reliably recognize them as communicating distinct emotional categories at levels above chance (for a review, see Calvo & Nummenmaa, 2016; Elfenbein & Ambady, 2002). Thus, regardless of the reliability with which they reflect one’s inner emotional experience, emotional facial expressions serve a social and communicative function (Fridlund, 2014; Keltner et al., 2006; Keltner & Gross, 1999; Lee & Anderson, 2017; Matsumoto et al., 2008; Niedenthal & Brauer, 2012; Van Kleef, 2009).

According to the social functional account, emotional facial expressions activate predictable emotional and behavioral responses from observers (e.g., Keltner & Kring, 1998; Van Kleef, 2010). For example, the prototypical expression of sadness, with its furrowed brow and downturned lips, generally elicits sympathy and help from observers (Marsh et al., 2007; Small & Verrochi, 2009). Alternatively, a friendly display, such as a smile, signals affiliation and safety, whereas a display of fear should alert an observer to external threats (Adams & Kleck, 2003; Marsh et al., 2005; Rychlowska et al., 2017). Thus, the ability to accurately perceive and extract meaning from expressions of emotion is an important social skill that aids in social coordination (Keltner & Haidt, 1999).

Deceptive Emotional Facial Expressions

Deception can be defined as a successful or unsuccessful deliberate attempt to create in another a belief that the communicator considers to be untrue (Vrij, 2008).
While there is evidence that people can accurately discriminate between expressions of distinct emotions (e.g., happiness and sadness), the ability to discriminate between genuine expressions from those deliberately expressed for the purposes of manipulation (i.e., deceptive expressions) appears much poorer (e.g., Porter & ten Brinke, 2008; Stel & van Dijk, 2018). For decades, researchers have aimed to discover and quantify reliable cues to deception in the verbal and nonverbal behavior of liars compared to truth-tellers and to determine whether people can accurately distinguish those who have lied and those who have told the truth (e.g., DePaulo et al., 2003). Although much of this research on deception has focused on false intentions, statements, or opinions, some research has specifically focused on deceptive emotional facial expressions (Ekman et al., 1988; Hurley & Frank, 2011; Porter & ten Brinke, 2008; ten Brinke et al., 2012; ten Brinke & Porter, 2012a). Deceptive emotional expressions can be simulations that occur when an expression is adopted but is not actually accompanied by a genuine, felt emotion (e.g., a person smiles despite not feeling any happiness) or masks that conceal a felt emotion with a different, unfelt emotional expression (e.g., a person experiencing sadness attempts to hide their emotion). An underlying emotion may also be neutralized when it is intentionally inhibited to express no emotion on the face. Each of these acts is considered deceptive to the extent that they are used intentionally for the purpose of misleading an observer about one’s true emotional state (Vrij, 2008).

Deceptive facial expressions appear to differ in subtle ways relative to genuine facial expressions borne of real, felt emotion. According to the inhibition hypothesis (Darwin, 1872; Ekman, 2003), deceptive facial expressions may be revealed by at least two possible outcomes. First, deceivers attempting to simulate an unfelt emotion might
not be able to pose the expression adequately, resulting in missing facial actions relative to a genuine expression (Ekman, 2003; Ekman & Friesen, 1982; ten Brinke et al., 2012). Secondly, deceivers attempting to mask a genuinely felt emotion might fail in doing so, resulting in leakage of facial actions that reveal the underlying felt emotion (Ekman et al., 1988; Porter & ten Brinke, 2008). Relatedly, deceptive compared to genuine facial expressions may involve greater left–right morphological asymmetry (Dopson et al., 1984; Ekman et al., 1981; Hill & Craig, 2002) or differ dynamically, such as having a more abrupt onset, longer apex, or an offset that is abrupt or irregular (Ekman & Friesen, 1982; Hess & Kleck, 1990; see also Horic-Asselin et al., 2020).

The first to draw attention to the idea that genuine and deceptive displays of emotion may differ visibly was a French physiologist named Guillaume Duchenne (Duchenne & Cuthbertson, 1862/2006). He proposed that a key difference of a genuine compared to a false smile was the activation of the orbicularis oculi—a muscle around the eyes which pulls the cheeks up while lowering the brow, creating ‘crow’s feet’ in the outer eye corners (Ekman, 1992). Although recent work by Gunnery, Hall, & Ruben (2013) suggests that this muscle can be deliberately activated by a substantial proportion of people (71%), the absence of its activation may still serve as a subtle cue to deception in some contexts. For example, Ekman, Friesen, and O’Sullivan (1988) recorded nursing students while watching two films: a pleasant and emotionally neutral (nature) film and then an unpleasant and emotionally evocative (amputations and burns) film. While they watched each film, an interviewer blind to the film they were watching asked them a series of questions about how they were feeling. During the emotionally neutral film, participants were asked to be honest about how they felt, whereas during the emotionally
evocative film, they were asked to be deceptive by concealing any fear, distress, or
disgust. The nursing students’ facial actions were coded with the Facial Action Coding
System (FACS), which taxonomizes facial movements by coding independent facial
actions (i.e., action units; Ekman & Friesen, 1982). Results revealed that during the
emotionally evocative film, deceptive (vs. honest) participants displayed more masking
(vs. genuine) smiles. Specifically, masking (vs. genuine) smiles did not include activation
of orbicularis oculi, pars orbitalis (AU6)—which pull the skin towards the eye, causing
crow’s feet wrinkles—and instead included only activation of the zygomaticus major
(AU 12), which pulls the lip corners obliquely. Deception was also associated with facial
action units associated with fear, disgust, contempt, sadness, and anger (see also Ekman
& Friesen, 1982). Thus, while the nursing students’ deceptive facial expressions engaged
intended facial actions in the lower face (i.e., smiling), leakage of unintended facial
actions occurred in the upper face.

More recently, Porter and ten Brinke (2008) completed a more comprehensive
investigation of genuine and falsified facial expressions, including happiness, sadness,
fear, and disgust. Using a similar paradigm to Ekman et al. (1988), participants were
asked to display a genuine, simulated, masked, or neutralized expression in response to
emotionally evocative images while their expressions were videotaped and subsequently
analyzed frame-by-frame with FACS. Results revealed that masked emotions, in
particular, resulted in more leakage of inconsistent facial actions and that negatively-
valenced emotions were more likely to involve leakage than happiness. Participants were
largely successful in deceptively neutralizing felt emotion, however, resulting in no
significant difference of leakage compared to genuine expressions. Importantly, findings
did not support the notion of *micro-expressions*—complete, full-face expressions of felt emotion that flash across the face in 1/25\(^{th}\) to 1/5\(^{th}\) of a second (Ekman & Friesen, 1969)—as reliable cues to deception. First, instances of leakage that lasted this short duration emerged as partial- (not full-) faced expressions: they occurred in either upper or lower face only. Additionally, most instances of inconsistent emotional leakage occurred for much longer durations than previously proposed—on the order of 0.4 to 2.15 seconds (Matsumoto & Hwang, 2018; Porter et al., 2012; Yan et al., 2013).

Other experimental work using designs with greater mundane realism finds similar results. For example, in a mock crime interrogation paradigm, Frank and Ekman (1997) gave participants an opportunity to steal $50 from a briefcase and were told that if they could convince an interrogator that they did not steal the money, they could keep it. Importantly, they were also told that if they could not convince the interrogator of their innocence, they would have to forfeit their participation fee of $10, the $50 they stole, and would be punished by enduring one hour of randomly sequenced white noise blasts at 110 decibels. After coding participants’ videotaped interrogation interviews, results revealed that the presence or absence of facial actions associated with prototypical expressions of fear and disgust could differentiate 80% of liars and truth-tellers.

While laboratory-produced stakes and efforts to increase mundane realism suggest that some subtle cues to deceptive emotional expressions exist (e.g., Frank & Ekman, 1997), research involving real, high stakes lies and truths provides additional evidence. Specifically, deceptive murderers, pleading for the safe return of a missing relative that they were later convicted for killing, are less likely to engage facial actions associated with prototypical displays of sadness (i.e., furrowed brow; AU 1+4), but more
likely to engage facial actions associated with prototypical happiness (i.e., AU 12; ten Brinke et al., 2012, 2012).

One potential explanation of why leakage or failed simulations of prototypical morphology may occur is due to the relative controllability of action units associated with the basic expressions of emotion. For example, several studies have found that some facial actions are more voluntarily controllable than others (e.g., Ekman et al., 1980; Gosselin et al., 2010). Ekman (2003) proposed that action units (AUs) could be categorized as those that are not readily subject to voluntary control (reliable action units) and those that are (versatile action units). Indeed, Mehu, Mortillaro, Bänziger, & Scherer (2012) found that reliable (vs. versatile) AUs proposed by Ekman (2003) were more difficult for participants to control voluntarily. Moreover, when posing or feigning emotions, voluntary control of specific AUs may also result in co-activation of unintended AUs (Gosselin et al., 2010), resulting in inconsistent expressions, or expressions that deviate from prototypical displays, such as those found in the nursing students described above (Ekman et al., 1988). Further, reliable action units may better reveal deception in increasingly emotional contexts. For example, additional work investigated participants who were filmed displaying genuine and deceptive facial expressions while viewing high- and low-intensity emotional images, revealing that high (vs. low) intensity emotional images led to higher rates of emotional leakage in upper (but not lower) face (Porter et al., 2012).

In the context of deception research, Hurley and Frank (2011) identified the relative utility of reliable versus versatile action units using a mock crime paradigm. Specifically, they randomly assigned participants to either steal or not steal a pair of
movie tickets from an envelope and were subsequently interviewed about the theft of the tickets. If they could convince the interviewer that they did not steal the tickets, truth-tellers were given one ticket, whereas liars were given two tickets as a bonus. They were also told that if they were unable to convince the interviewer of their innocence, they would receive no reward and would endure a long and boring questionnaire as a punishment. Importantly, participants were also randomly assigned to either suppress smiles, suppress eyebrow movements, or were told about the importance of convincing the interviewer of their honesty (control). FACS coding of interviews with participants indicated that while participants who lied or told the truth were largely successful in suppressing smiles when instructed to do so, liars (vs. truth-tellers) were not able to suppress their brow movements—a reliable facial action—despite explicit instruction.

In sum, although differences can be subtle, evidence suggests that deceptive displays of emotion differ from genuine expressions borne of felt emotion. Findings across highly controlled experiments and ecologically valid studies with real, high stakes provide a slowly growing body of evidence to support Darwin’s (1872) inhibition hypothesis: the presence of inappropriate facial actions (i.e., leakage) or absence of appropriate facial actions occur during deceptive emotional expressions since some facial actions are harder to voluntarily suppress or simulate, respectively.

**Detecting Deceptive Emotions**

Despite evidence that subtle behavioral indicators of veracity exist in facial expressions, people’s ability to detect deceptive emotional expressions is mixed. For example, some studies have found that observers are not able to discriminate between genuine and deceptive displays of sadness, fear, surprise, or disgust, above chance (Hess
& Kleck, 1994; Porter et al., 2012; Porter & ten Brinke, 2008; Soppe, 1988; Stel & van Dijk, 2018; Zlosteanu et al., 2019). Other studies, in contrast, have found that observers are able to discriminate between genuine and deceptive displays of happiness, sadness, fear (McLellan et al., 2010), enjoyment compared to non-enjoyment smiles (Miles & Johnston, 2007), traces of negative emotions in smiles (Perron et al., 2016), and amusement, surprise, disgust, and sadness (Namba et al., 2018). As a potential explanation for these mixed findings, a recent meta-analysis indicates that the variability in observers’ accuracy in detecting deceptive emotions may be due to the strength and perceivability of the cues displayed (Hartwig & Bond, 2011). Building upon this explanation, it is possible that the manner in which we visually process faces may play a role in explaining accuracy in detecting deceptive emotional expressions. Here, I review how people visually process faces, in general, and emotional expressions, in particular.

**Visual Processing of Faces**

Although most objects are visually processed based on their individual parts (e.g., Biederman, 1987), the face is different in that it is processed *holistically*: we identify and recognize a face as a complete unit or gestalt, rather than a sum of its parts (e.g., a pair of eyes, a nose, and a mouth; Farah et al., 1998; Peterson & Rhodes, 2006; Piepers & Robbins, 2012). Related to holistic processing is *configural processing*, or processing the interrelationships between different facial features, such as the shape and position of the nose, mouth, and eyes (Carey & Diamond, 1977). Configural processing involves two forms of information: *first-order relational properties*, which refer to the basic configuration of features of a face (e.g., eyes above the nose), and *second-order relational properties*, which refer to variations in the spacing between and positioning of
the features. While first-order relational properties are important for detecting a face (vs. another object), second-order relational properties allow discrimination between different faces (Diamond & Carey, 1986; Tsao & Livingstone, 2008). Configural processing is thus best described as the integration of all or some of the second-order information within a face and, importantly, suggests that the face is processed holistically (i.e., as a gestalt; Piepers & Robbins, 2012). As such, holistic face processing is said to be qualitatively different from the sum of its individual parts since it results in emergent features—

features that only become apparent when two or more of a face’s basic features are processed simultaneously. For example, Tanaka and Sengco (1997) showed participants faces with two configurations: eyes close together or eyes far apart. After presenting one of the two faces, participants were tested for their recognition of facial features in isolation, in a new face configuration, or in the previously presented (old) configuration. Results revealed that participants performed best when tested with the old configuration, followed by the new configuration, and worst with facial features (nose, mouth, or eyes) in isolation. Moreover, while altering the spatial location of the eyes impaired recognition of eye features, it also impaired the recognition of nose and mouth features, even though the nose and mouth were not spatially manipulated. Together, these results suggest an interdependency of featural and configural information to recognize faces. This relational/configural model of face processing suggests that configural processing is inseparable from processing individual parts of the face; emergent features of the face arise from the interrelations between isolated features and are encoded together (see Wallis, 2013).
Alternatively, Piepers and Robbins (2012) proposed a holistic/part-based model, suggesting that holistic and part-based processing are parallel processes, separable, and equally important to face processing. In this model, part-based processing refers to the processing of individual features of the face and is also sometimes referred to as analytic processing (Tanaka et al., 2012). Moreover, in this model, configural processing and holistic processing are taken to mean the same thing only if configural processing involves the integration of all (vs. some) of the first- and second-order relations between facial features. Although there is a lack of consensus as to the nature of holistic processing, particularly because there is a lack of one-to-one mapping between the theoretical construct of holistic processing and how it is measured (see Richler et al., 2012; Richler & Gauthier, 2014; Watson & Robbins, 2014), below I review a variety of approaches to measure and manipulate holistic processing (McKone et al., 2006; Tanaka & Gordon, 2011).

**Measuring and Manipulating Holistic Face Processing**

The evidence for holistic processing of faces starts with the disproportionate inversion effect (Yin, 1969). In a typical paradigm, faces and non-face objects are shown both upright and inverted (i.e., upside down, or rotated 180°). In both recognition and perception tasks, faces and other objects alike show an inversion effect: accuracy is higher and reaction time is shorter when the stimuli are presented upright compared to inverted. However, while the inversion effect for non-face objects is relatively small, typically ranging from 0–8%, the inversion effect for faces is much larger, typically ranging 20–25% (de Gelder et al., 1998; Reed et al., 2003; Scapinello & Yarmey, 1970). The inversion effect has also been shown for judgments of target gender and facial
expressions of emotion, compared to non-face objects (Pallett & Meng, 2015). This suggests that viewing inverted (vs. upright) faces makes it difficult to extract the correct relationships between face parts, presumably because inversion disrupts holistic processing of the face but maintains its local features, thus requiring part-based processing of isolated features (Leder & Bruce, 1998). The disproportionate inversion effect, however, may only provide indirect evidence of holistic processing, as it could be argued that both non-face objects and faces are qualitatively processed the same way, but that the magnitude of the effect is simply greater for faces (Michel et al., 2006; Sekuler et al., 2004). However, fMRI work has shown that inverted (vs. upright) faces recruit the ventral extrastriate regions that respond preferentially to non-face objects (e.g., houses) instead of activating only face-selective regions (Haxby et al., 1999). Additionally, the paradigm for the disproportionate inversion face effect is limited in that the disruption of holistic processes is inferred from comparing accuracy and reaction time differences between upright and inverted faces rather than manipulating holistic processes directly (Tanaka & Simonyi, 2016).

Another approach supporting the holistic processing of faces is the composite face task (Richler et al., 2015; Rossion, 2013; Young et al., 1987). In this task, a composite face is created by combining the top and bottom halves of two different face identities, and participants are asked to identify only the cued top (or bottom) half of the composite face (the un-cued half of the face should be irrelevant to the task, in principle). When two face parts are aligned horizontally to create a single face, participants show difficulty in attending to the cued half of the face, as evidenced by reduced accuracy and slower reaction times. This effect is referred to as holistic interference—difficulty in selectively
attending to information in a cued region of a face without being influenced by
information in other regions. When the halves are horizontally misaligned or when the
face is inverted, however, holistic interference is greatly reduced or eliminated (Young et
al., 1987). The holistic interference effect has been shown with both familiar (e.g., Young
et al., 1987) and unfamiliar faces (Grand et al., 2004; Michel et al., 2006). Even first
impressions of faces, such as ratings of trustworthiness, show evidence of holistic
interference (Todorov et al., 2010). In short, the face composite task demonstrates how
difficult it can be to restrict our attention to one region of the face while ignoring other
regions of the face, suggesting that we process the faces holistically.

An additional approach to test holistic processing involves the part/whole task
(Tanaka & Farah, 1993). In this task, participants first learn name–face associations (e.g.,
Dana, Alex, Sam). Next, participants complete a memory test for face parts from the
studied name–face associations in a forced-choice recognition task. Critically, the face
part (e.g., Dana’s nose) is tested either in isolation or in the context of a whole face.
Importantly, the target and foil faces are identical, except for the face part under test (i.e.,
Dana’s nose). In other words, the target’s eyes and mouth are kept constant in target and
foil faces. The difference in part- and whole-face recognition is an index of holistic
processing: If memory for the face part (e.g., Dana’s nose) is integrated into holistic face
representation, then the recognition of the face part should be better in the whole-face (vs.
isolation) test condition, whereas if a face is remembered in terms of its constituent parts,
recognition should equivalent when presented in the whole-face (vs. isolation) condition.
Results of Tanaka and Farah (1993) reveal that recognition memory is better in the
whole-face (77%) condition compared to the isolation (65%) condition. These results are
consistent with follow-up work that examined whether manipulating configural information (e.g., eyes close together, eyes far apart) would interfere with the recognition of features (e.g., a nose) when tested in isolation, with a new face configuration, and with the old configuration (Tanaka & Sengco, 1997). Results revealed that participants were most accurate at recognizing a feature when presented in the old configuration (77%), followed by the new configuration (72%), and least accurate when tested in isolation (65%).

In sum, several paradigms have been used to measure or manipulate holistic processing. The disproportionate inversion effect suggests that faces (vs. other objects) shown inverted (vs. upright) results in less accuracy and longer reaction times. The composite face task reveals that when two faces of different identities are made into a composite, selectively attending to the target region of the face becomes difficult (holistic interference) but is much less difficult when the face parts are misaligned. Moreover, the part-whole task suggests that face parts are better remembered in the context of the whole face compared to when presented in isolation. Across several paradigms that measure and manipulate holistic processing, it is clear that faces are processed holistically, at least in recognizing and identifying a face (for reviews, see Behrmann et al., 2014; McKone et al., 2006; Tanaka & Simonyi, 2016).

**Processing Emotional Facial Expressions**

Like face detection, emotional facial expressions are processed quickly. For example, results from an ERP study demonstrate that emotional information from the face is detected with a latency as low as 80ms, and crude affective categorization can occur as early as 100ms (Palermo & Rhodes, 2010). In perceptual tasks, emotional
information from a face can be detected with even very brief exposures of 10ms (Sweeny et al., 2013). To better understand how emotional expressions are processed visually, early work used the face composite paradigm with emotional expressions (Calder et al., 2000; White, 2000). Using this paradigm, as described above, when two face halves were aligned displaying conflicting emotions (e.g., happiness and anger), holistic interference occurred, yielding less accurate recognition and longer reaction times to identify the emotion in the cued target half of the face. In contrast, when the two face halves were aligned and displayed the same expression, holistic facilitation (i.e., higher accuracy and shorter reaction times) occurred (Calder et al., 2000; Wegrzyn et al., 2015). Other researchers, however, have argued that the process of emotion recognition can be part-based—focusing on specific parts of the face—and not the integration of the parts into a whole representation (Chen & Chen, 2010; Ellison & Massaro, 1997; Leppänen et al., 2007). Rather than viewing emotion recognition as either holistic or part-based, other researchers claim it may be more accurate to characterize emotional facial expression recognition as lying on a part-based to holistic processing continuum (Farah, 1991; Tanaka et al., 2012).

Using the composite face paradigm, Calder, Young, Keane, and Dean (2000) showed participants faces with lower and upper parts that were either emotionally congruent or incongruent. As expected, participants were slower to identify the expression in the target half (top or bottom) of the face if the composite was incongruent (vs. congruent), suggesting holistic interference (see also Wegrzyn et al., 2015). Importantly, however, when the faces were horizontally misaligned, there was no longer an effect of holistic interference. Results from Tanaka, Kaiser, Butler, and Le Grand
are consistent with Calder et al. (2000). Specifically, Tanaka et al. (2012) also used composite faces that were either emotionally congruent (e.g., happy top, happy bottom) or incongruent (angry top, happy bottom), isolated bottom or top halves, or a composite that had a top (or bottom) that was neutral and the other half expressing either happiness or anger. They found that participants were most accurate in identifying emotional expressions in the congruent condition and least accurate in the incongruent condition (Study 1). To identify when holistic interference would first occur, Study 2 used the same manipulations but also included different exposure durations: 20ms, 60ms, 100ms, and 120ms. The effect of holistic interference for incongruent expressions occurred as early as 20ms and 60ms for angry and happy expressions, respectively. And, replicating Calder et al. (2000), in Study 3, Tanaka et al. (2012) found that accuracy was higher and reaction time quicker when incongruent faces were presented misaligned (vs. aligned). These results provide evidence of rapid holistic interference when participants were presented with an incongruent face—information in the to-be-ignored half of the face impaired recognition of the emotion displayed in the target half (Richler et al., 2012). Even when the composite face paradigm uses primarily neutral faces and weakly modulates the emotional intensity of the distractor half of the face, the holistic interference effect grows stronger as emotional intensity increases (Gray et al., 2017). Since deceptive (vs. genuine) facial expressions of emotions often involve incongruent expressions that result when leakage occurs or critical facial actions are absent (e.g., Porter & ten Brinke, 2008; ten Brinke et al., 2012), it is possible that holistic interference is, in part, responsible for failed detection of these deception cues, particularly when
situational or contextual information is absent. In other words, emotional information in one part of the face distracts from cues to deception in the other part of the face.

**Visual Saliency and Distinctiveness of Features Bias Our Interpretations**

Visual saliency refers to the conspicuousness of an image or image region in relation to its surroundings, operationalized as a combination of local contrast, spatial orientation, and energy in computational models of visual attention (Borji & Itti, 2013; Torralba et al., 2006). These computational models mimic the response properties of retinal neurons, lateral geniculate nucleus, thalamus, and V1 via algorithm simulation (e.g., Walther & Koch, 2006). In facial expressions of emotion, for example, a smiling mouth is more salient than any other region of happy and non-happy faces (Calvo & Nummenmaa, 2008). A visually salient feature guides visual attention (Itti & Koch, 2000) and attracts gaze early (e.g., Calvo & Nummenmaa, 2008). Distinctiveness refers to the degree to which a facial feature is associated with a particular facial expression but not others, allowing an observer to recognize an expression as belonging to a particular category (i.e., the feature is diagnostic of a particular emotion). While a smiling mouth is the most distinctive feature of happy expressions, changes in the eye region are more distinctive for expression of anger and fear (Calvo et al., 2014; Smith et al., 2005; Wegrzyn et al., 2015). Distinctiveness should reduce ambiguity wherein observers selectively attend earlier and longer to regions or features that are most diagnostic, facilitating expression categorization accuracy. Indeed, in both static and dynamic displays of facial expressions of emotion, eye-tracking data indicates that the eye region is looked at earlier and longer for anger and sadness, the mouth region for happiness, the
nose–cheek region for disgust, and the eye and mouth regions roughly equally for surprise and fear (Calvo, Fernández-Martín, et al., 2018; Schurgin et al., 2014).

However, people do not only smile when feeling happiness, but may also do so for social or polite reasons, because of nervousness or embarrassment, or even sarcastically (Ambadar et al., 2009; Johnston et al., 2010; Krumhuber & Manstead, 2009). Calvo, Fernández-Martín, and Nummenmaa (2013) investigated how a smiling mouth influences observers’ perceptions of non-happy eyes. Since a smiling mouth is the most visually salient and distinctive feature of happy expressions, they reasoned that a smile might influence the perception of the eye region from extrafoveal (i.e., peripheral) vision, even prior to visual fixation on the mouth. Specifically, they predicted a smiling mouth would ‘radiate’ toward surrounding areas, ‘projecting’ an impression of happiness even when only the non-happy eye region is foveally fixated (see Kontsevich & Tyler, 2004). Using the composite face paradigm, they found that a smiling mouth biased observers’ ratings of non-happy eyes across three experiments. Specifically, observers were cued to pay attention only to the eye region and were asked to rate whether happy faces (with the Duchenne marker) or incongruent composite faces were happy or not. Incongruent composite faces had either a smiling mouth or a Fourier scrambled mouth (control) combined with neutral, angry, sad, fearful, or surprised eyes. Results were consistent across three experiments: neutral eyes were most likely, and angry eyes were least likely to be influenced by a smiling mouth. However, none of the non-happy eye expressions were impervious to the biasing effect of the smile. This was the case when (a) observers’ foveal (but not extrafoveal) vision for the mouth was blocked by gaze-
contingent masking\(^1\), suggesting that extrafoveally presented smiles are accessed by covert attention (Study 1), (b) when the smiling mouth was presented 300ms after the eyes (Study 2), suggesting that the mouth can act against the correct initial evaluation of non-happy eyes, and (c) when faces were horizontally aligned compared to misaligned (Study 3).

Critical to the current investigation, Calvo, Fernández-Martín, and Nummenmaa’s (2013) Study 3 examined whether this biasing influence of the smiling mouth on eye expressions involves part-based or holistic processing. The smiling mouth biased observers’ responses for both aligned and misaligned faces, but the effect was roughly two-and-a-half times greater for aligned faces: the smiling mouth explained 70.6\% of the variance in judging the eyes as happy for aligned faces and explained only 28.1\% of the variance for misaligned faces. Additionally, reaction times for correct rejections of incongruent faces as not happy were longer in the aligned (vs. misaligned) condition. This suggests that the biasing effect of a smiling mouth on other regions of the face occurs strongly when faces are perceived holistically (i.e., aligned) and relatively weakly when faces are perceived in a part-based manner (i.e., misaligned). Together, these results suggest that when expressions are incongruent, the smiling mouth overshadows the information in the eye region, even when the smiling mouth is not directly fixated on, misleading observers to interpret non-happy eyes as if they were (see also Calvo et al., 2012, for a replication and extensions of Study 1). Together, these findings suggest that the evaluation of deceptive emotional facial expressions, which communicate different

\(^1\) An eye-tracker monitored observer saccades. If the observer initiated a saccade away from the eye region, the mouth region was masked by a black rectangle, eliminating the possibility of viewing the smiling mouth with foveal vision (i.e., directly).
emotions on the upper and lower face, may be biased by holistic interference. In particular, distinctive features—smiles in the lower face, and anger in the upper face—may obscure observers’ perception of other facial regions that contain cues to deception.

**Mixed Expressions of Emotion Cause Processing Disfluency**

A separate but related literature investigates the effects of *mixed* expressions, blends of two emotions across the entire face, which elicit perceptual and categorization difficulty and are susceptible to the influence of contextual information (e.g., Barrett & Kensinger, 2010; Halberstadt & Niedenthal, 2001). This work seeks to understand the mechanisms by which mixed facial expressions influence social judgments, such as trust. For example, Winkielman, Olszanowski, and Gola (2015) presented participants with faces that were pure anger, pure happiness, or intermediate blends (i.e., mixed) of anger and happiness. Participants were asked to categorize the faces on either emotional expression or gender (control). They were also asked to evaluate the faces on attractiveness and trust. Critically, it was expected that mixed (vs. pure) expressions would induce *processing disfluency*—characterized by longer reaction times, high resource demands, or other indicators of inefficient processing—resulting in negative affect that would be attributed to subsequent social evaluations of a target (Musch, 2013). Results revealed that participants took longer to categorize mixed (vs. pure) faces when judging emotional expression but not gender, suggesting that while mixed faces are objectively ambiguous, subjective (dis)fluency is task- or evaluation-dependent. Moreover, evaluations of attractiveness and trust followed a *U*-shaped curve wherein mixed (vs. pure) faces are relatively devalued—receiving lower ratings—on these social dimensions. This relative devaluation of mixed faces on attractiveness and trust was
mediated by categorization disfluency. In other words, when facial expressions involve inconsistency—akin to the leakage or absent morphology that appears in deceptive expressions—they take longer to evaluate, suggesting a change in processing style due to disfluency that negatively affects perceptions of trust. This effect is greatest when faces are maximally inconsistent and weaker when inconsistency is subtle—as in deceptive emotional expressions. Using a similar paradigm to Winkielman et al. (2015), findings from Olszanowski et al. (2018) suggest that trust judgments are influenced by both facial features related to valence—positively valenced features are judged as trustworthy—and social motivation—faces high in social dominance, such as anger, are judged as threatening, untrustworthy, and induce avoidance (Oosterhof & Todorov, 2008).

Specifically, participants rated pure happy (vs. sad) faces as more trustworthy (valence-relevant information) and pure sad (vs. angry) faces as more trustworthy (motivation-relevant information). These effects were qualified by processing disfluency: happy–sad mixed faces were rated as relatively less trustworthy, whereas anger–sadness mixed faces were not. This suggests that when forming impressions of trust, disfluency is more likely to combine with valence-related (vs. motivation-related) features of the face.

Relatedly, observers’ affective reactions depend on the type of incongruent (different emotions in the upper compared to lower face) expression. For example, Calvo, Gutiérrez-García, and Líbano (2018) explored factors that contribute to the discrimination between congruent happy and incongruent expressions. Specifically, they examined the relative contributions of visual saliency, distinctiveness, facial action units, and affective valence of congruent happy expressions and incongruent (e.g., smiling mouth, angry eyes) expressions. They found that observers judged congruent happy faces
as most pleasant, followed by smiling mouths with surprised or neutral eyes, those with fearful or sad eyes, those disgusted eyes, and those with angry eyes were rated as least pleasant. In follow-up work, affective valence—participants’ ratings of how emotionally positive or negative the faces were—was the strongest predictor of discrimination performance between happy and non-happy incongruent faces, controlling for facial action units and other physical properties (Del Libano et al., 2018). Similar to subjective disfluency reducing impressions of trustworthiness, negative affective reactions to incongruent expressions predict increased discrimination between happy and non-happy faces. Thus, an alternative hypothesis might be that holistic processing facilitates the subjective experience of disfluency when presented with an incongruent face. This experience may improve deception detection accuracy relative to a condition where holistic processing is interrupted.

The Present Research

Observers reliably recognize so-called basic facial expressions of emotion as distinct emotional categories above chance (Calvo & Nummenmaa, 2016) that elicit predictable subsequent emotional and behavioral responses (van Kleef & Côté, 2022). Not all emotional facial expressions, however, reveal an expresser’s underlying emotion, and may be used to intentionally mislead an observer (Ekman, 2003). A growing body of evidence suggests that genuine and deceptive facial expressions of emotion differ (e.g., Dopson et al., 1984; Hess & Kleck, 1990). Although these differences—such as leakage of an underlying emotion or absence of appropriate morphology—have been identified (Porter & ten Brinke, 2008; ten Brinke et al., 2012), results are mixed as to whether observers can reliably discern deceptive from genuine expressions (e.g., McLellan et al.,
2010; Zloteanu et al., 2019). One potential explanation is that cues to deception on the face may be weak or inconsistent (DePaulo et al., 2003; Hartwig & Bond, 2011). Accordingly, some researchers have argued that deception detection accuracy may be improved if cues were made stronger and more perceptible. I consider holistic processing as a visual mechanism by which cues to emotional deception on the face may become more or less obvious to the perceiver.

On the one hand, research on social impressions of mixed facial expressions (i.e., full-faced blends of different emotions) suggests that these faces are rated as relatively less attractive and less trustworthy than pure faces, an effect mediated by observers’ subjective experience of processing disfluency (Olszanowski et al., 2018; Winkielman et al., 2015). Indeed, impressions of mistrust and deception are strongly correlated (e.g., Au & Wong, 2019). Thus, these mixed expressions, albeit artificially produced, are conceptually similar to deceptive expressions, and would suggest that subjective disfluency may serve as a potential cue to deception in the evaluation of emotional facial expression veracity (Olszanowski et al., 2018; Winkielman et al., 2015). Alternatively, it is possible that the emergent perceptual features of faces that involve inconsistent emotional expression in the upper and lower halves of the face obscure this cue to deception. Since people process faces holistically (Richler & Gauthier, 2014) and rapidly attend to diagnostic regions of the face when a particular emotion is expressed (Calvo, Fernández-Martín, et al., 2018), one region of the face may bias (Calvo, Fernández-Martín, et al., 2013) or interfere (Tanaka et al., 2012) with people’s ability to perceive these potential cues to deception in other regions of the face (Iwasaki & Noguchi, 2016). Consistent with this hypothesis is evidence that interrupting holistic processing by
misaligning incongruent faces results in higher emotion recognition accuracy and faster reaction times in a cued part of the face (Calder et al., 2000; Tanaka et al., 2012) and substantially reduces the biasing effect one region of the face has on the other (Calvo et al., 2012; Calvo, Fernández-Martín, et al., 2013). Thus, since there is some evidence that deception emotions involve leakage that occurs in either the upper or lower half of the face (Porter et al., 2012; Porter & ten Brinke, 2008), interrupting holistic processing may increase observers’ ability to identify the incongruence among the face halves by reducing holistic interference and the biasing effect of one half of the face on the other. In the current set of studies, I pit these alternative hypotheses against each other (see Table 1), borrowing insights from vision science on how people visually process facial expressions of emotion to test whether interrupting holistic processing improves or impairs the ability to identify deceptive emotional expressions.

Table 1: Competing Hypotheses

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<thead>
<tr>
<th>Hypothesis</th>
<th>Prediction</th>
<th>Pattern of Results</th>
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<tbody>
<tr>
<td>Subjective Disfluency</td>
<td>Subjective disfluency experienced from mixed expressions may serve as a potential cue to deception in the evaluation of emotional facial expression veracity</td>
<td>Aligned (vs. misaligned) incongruent (or posed) expressions would be rated as less genuine</td>
</tr>
<tr>
<td>Account</td>
<td></td>
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<tr>
<td>Holistic Processing</td>
<td>One region of the face may bias or interfere with perceiving cues to deception. Interrupting holistic processing reduces this bias, increasing the ability to perceive incongruence among face halves.</td>
<td>Misaligned (vs. aligned) incongruent (or posed) expressions would be rated as less genuine</td>
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<tr>
<td>Account</td>
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Chapter Two: Pilot Study

The Pilot Study aimed to examine whether disrupting holistic processing would enhance or impair observers’ ability to detect (artificially created) incongruence in emotional facial expressions. If incongruence, as a proxy cue to deception, is obscured by holistic processing (Calvo, Fernández-Martín, et al., 2013; Iwasaki & Noguchi, 2016; Tanaka et al., 2012), I would expect that observers’ ratings of genuineness for incongruent expressions would be lower for misaligned compared to aligned faces. Such an effect would not be expected for congruent expressions: Tanaka et al. (Experiment 3; 2012) found that for congruent angry and happy expressions, there was no difference in emotion identification accuracy when comparing aligned to misaligned faces (c.f., Calder et al., 2000; White, 2000). This pattern of results would suggest that by misaligning the face, versatile action units which are activated during inconsistent expressions (Gosselin et al., 2010) no longer obscure observers’ ability to perceive the ‘leakage’ of reliable action units that serve as a cue to deception. Alternatively, if holistic processing facilitates the subjective experience of disfluency and leads to negative social evaluation for facial expression incongruence, as for mixed faces (Olszanowski et al., 2018; Winkielman et al., 2015), I expect that this experience may improve deception detection accuracy, compared to when holistic processing is interrupted by misalignment.
**Method**

**Participants and Design**

Seventy-six participants (50 females, 21 males, 3 non-binary, 2 preferred not to answer) were initially recruited from the University of Denver and received course credit for their participation ($M_{age} = 20.93$, $SD_{age} = 6.13$, range = 18–29). The sample was composed of White (75.38%), Asian (5.20%), mixed-race (3.90%), Hispanic (3.90%), Black (2.60%), Native American (1.30%), and 1.30% preferred not to say. A 2 (Alignment: aligned, misaligned) $\times$ 2 (Emotional Congruence: congruent, incongruent) within-subjects design was used. Sixty-seven participants completed the study. A sensitivity power analysis indicated that with a sample size of $n = 67$, 144 trials, and $\rho = 0.5$ among trials, we had 95% power to detect an effect as small as $\eta^2 = .08$, which is considered a medium effect by Cohen (2013) standards.

**Stimuli**

Four faces of white men and four faces of white women were adopted from the NimStim face set (Tottenham et al., 2009). Previous work created linear interpolations (i.e., morphs) of emotional expression for each face using Fantamorph software (Mihalache et al., 2021). For the present study, each of the eight target faces expressed happiness or anger at three levels of emotional intensity: 20%, 40%, and 60%. Happy and angry expressions were used based on following previous research using a similar paradigm (e.g., Tanaka et al., 2012). Moreover, distinctive features—smiles in the lower face or anger in the upper face—may obscure observers’ perception of cues to deception (e.g., Calvo et al., 2013). Faces were first cropped at the bridge of the nose horizontally to make stimuli that manipulated emotional congruence. Faces were *emotionally congruent*
when the upper and lower half of the face displayed happiness. Faces were *emotionally incongruent* when the face displayed anger in the upper face and happiness in the lower face. No faces displayed anger in the lower half of the face. Given the context prompt for the procedure of the current study (see below), anger was displayed only in the upper face since these action units are considered *reliable* (vs. versatile) action units (Gosselin et al., 2010; Mehu et al., 2012), and because non-Duchenne or fake smiles typically do not involve the activation of orbicularis oculi (cheek raiser) in the upper face (e.g., Ekman & Friesen, 1982; but see also Gunnery et al., 2013). To create a sufficient number of emotional congruent and incongruent stimuli, multiple levels of expression intensity in the upper and lower face were fully crossed. In other words, the lower face displayed happiness at 20%, 40%, or 60% and was combined with all possibilities in the upper face: happiness (20%, 40%, or 60%) or anger (20%, 40%, or 60%). To manipulate holistic processing, each of these faces was presented either *aligned*, wherein the face halves created an intact composite, or *misaligned*, wherein the faces were horizontally misaligned with a 30% offset (see Figure 1). A thin black line was inserted in between the upper and lower half of the face at the middle of the nose for all faces, as previous work indicates that the absence of a delineation between the upper and lower face halves may artificially inflate the magnitude of the composite-face effect (Gray et al., 2017; Rossion & Retter, 2015). In total, each of the four targets had 36 variations of face alignment, emotional (in)congruence, and intensity, resulting in a total of 144 stimuli faces for the present study. Importantly, since each target presented every possible combination of congruent and incongruent expression, extraneous factors that might
affect observers’ genuineness ratings (e.g., attractiveness) were held constant across all levels of emotional congruence and face alignment.

Figure 1. Example stimuli from the Pilot Study depicting an aligned face (left) or misaligned face (right) to manipulate holistic processing. In (A) upper and lower face feature a congruent expression of happiness at 60% intensity in both the upper and lower face. In (B) upper face is anger at 60% intensity with the lower face at 60% happiness.

Procedure

After providing informed consent, participants first completed a demographic questionnaire. Specifically, participants indicated their age, gender, ethnicity, undergraduate major, whether English is their native language, whether there was any reason to not use their data, if they were currently under the influence of any substances that might impair their ability to complete the study, how tired they were before the study (1 - not at all to 4 - very tired), how they were feeling (1 - very poor to 4 - very well), and whether there is anything else that might affect their performance. Participants were then redirected to a webpage to complete the primary study, detailed below.

Context Prompt. Participants were first informed that facial expressions may reflect genuine emotion but can also be faked or posed. Specifically, they were told that a genuine expression occurs when somebody smiles and really feels happy, whereas a faked expression is when somebody displays a particular emotional expression without
feeling that emotion or adopts a different emotional expression to cover up how they actually feel. As an example, they were told that people may choose to cover up feelings of anger by expressing a more socially appropriate emotion, like happiness, instead. Next, they were told that while people find it easy to smile with their mouth even when they don’t feel happy, the upper part of the face can provide useful cues to deception. This is consistent with previous research that indicates AUs in the upper (vs. lower) face are more difficult to voluntarily control, resulting in activation of unintended AUs or ‘leakage’ (Gosselin et al., 2010; Mehu et al., 2012). Participants were told that the upper face could indicate whether the expression reflects genuine happiness or if the person is trying to cover their feelings of anger with fake happiness. They were then told that during the study, they would be rating how genuine various facial expressions looked to them. Consistent with previous procedures in holistic processing of emotion with the composite face paradigm (e.g., Calder et al., 2000; Tanaka et al., 2012), participants were cued to pay attention to only one half of the face. In the context of the current study, participants were instructed that because cues to veracity will appear in the upper facial region, they should only pay attention to the upper face when making their judgments. Instructions were as follows:

In the following study, you will be rating facial expressions. Sometimes facial expressions reflect genuinely felt emotion, but other times expressions are faked or posed (e.g., to be polite). An example of a genuine expression is when somebody smiles and they really feel happy, like when they get a present or see something funny. An example of a faked expression is when somebody smiles without feeling any emotion, or to cover up another emotion they actually feel. For example, people may choose to cover up feelings of anger by expressing a more socially-appropriate emotion, like happiness, instead. People find it easy to smile with their mouth, even when they do not feel happy, but the upper part of the face can provide useful cues to deception. Specifically, the upper face will
indicate whether the expression reflects genuine happiness or if the person is trying to cover their feelings of anger with fake happiness. For the following facial expressions, you will rate how genuinely happy they look. In this task, pay attention only to the upper face to make your judgments.

**Practice Trials.** Prior to beginning the primary experiment, participants were presented with examples (of a target not used in the primary study), which included faces aligned and misaligned. Participants then rated the faces they had just seen on a scale from -7 (*completely fake*) to +7 (*completely genuine*), with the prompt, “As an attempt to look happy, how genuine does this expression look to you?”.

**Primary Experiment.** Each trial began with a fixation point in the center of the screen presented for a randomly determined duration of 500, 600, or 700ms. Participants were then presented with a target face and rated each on a scale from -7 (*completely fake*) to +7 (*completely genuine*), with the prompt, “As an attempt to look happy, how genuine does this expression look to you?” Each of the 144 faces was presented individually in random order. Participants could spend as much time as they needed on each trial to make their judgment (see Figure 2).

*Figure 2. A sequence of two trials during the primary experiment. The fixation cross was displayed for either 500, 600, or 700ms, followed by an aligned or misaligned face wherein participants were asked to make their genuineness judgment.*
**Additional Judgments.** After the primary task, participants were also asked how difficult they found the task on a scale from 1 (very easy) to 5 (very difficult) ($M = 2.57, SD = 1.08, n = 21$), provided a dichotomous judgment of which type of face made it easier to detect genuine happiness (aligned: 57.10%, misaligned: 42.90%, $n = 21$), and completed an open-ended question about whether they had any guesses for what the primary experiment was about. Lastly, participants were thanked for their participation and debriefed.

**Results**

A 2 (Alignment: aligned, misaligned) \(\times\) 2 (Congruence: congruent, incongruent) within-subjects ANOVA was performed on observers’ ratings of genuineness.$^3$ While results revealed no main effect of alignment, $F(1, 66) = 2.12, p = .15, \eta^2_p = .03$, there was a significant main effect of congruence, $F(1, 66) = 332.74, p < .001, \eta^2_p = .83$. Specifically, congruent faces ($M = 0.88, SE = 0.16$) were rated as more genuine than incongruent faces ($M = -2.19, SE = 0.17$). The main effect of congruence, however, was qualified by a significant alignment \(\times\) congruence interaction, $F(1, 66) = 41.02, p < .001, \eta^2_p = .38$. Bonferroni-corrected post-hoc tests were performed to examine the interaction. For congruent faces, misaligned faces ($M = 1.16, SE = 0.18$) were rated as more genuine than aligned faces ($M = 0.62, SE = 0.16$), $t(66) = 4.51, p < .001, d = 0.55$, contrary to my hypothesis. For incongruent faces, misaligned faces ($M = -2.33, SE = 0.18$) were rated as less genuine than aligned faces ($M = -2.05, SE = 0.18$), $t(66) = -2.74, p = .008, d = -0.33$.

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$^2$ Most participants did not complete the follow-up questions that followed the primary experiment. This was the case for Study 1 and Study 2, as well.

$^3$ See Appendix A for additional analyses that include emotional intensity as an independent variable. Appendix A also includes an analysis of observers’ reaction time to making genuineness ratings.
consistent with the notion that interrupting holistic processing improved the detection of emotional incongruence, as in deceptive expressions of emotion (see Figure 3).

![Figure 3](image)

**Figure 3.** The effect of emotional congruence and alignment on observers’ genuineness ratings in the Pilot Study. Error bars represent ± 1 standard error.

**Discussion**

Consistent with the hypothesis that interrupting holistic processing would improve the detection of emotional incongruence, incongruent faces were rated as less genuine when misaligned (vs. aligned). This contrasts with what I would expect if disfluency could serve as a reliable cue to expression incongruence; if that were the case, aligned (vs. misaligned) incongruent faces would be given lower genuineness ratings. Thus, when focusing on the effect of alignment on the evaluation of incongruent faces, specifically, results are consistent with improved deception detection by interrupting holistic processing. Neither of the proposed mechanisms, however, would have predicted that congruent faces would be rated as more genuine when misaligned (vs. aligned). This finding is inconsistent with previous research by Tanaka et al. (2012), who found that...
alignment did not affect accuracy in identifying congruent angry and happy faces. While speculative, misaligned (vs. aligned) congruent faces may have been rated as more genuine because, as the instructions stated, “People find it easy to smile with their mouth, even when they do not feel happy, but the upper part of the face can provide useful cues to deception.” It is possible that misaligned faces made the task of identifying genuineness of happy expressions in the upper face easier, particularly if participants were already suspicious of deception occurring. This, however, contrasts sharply with previous findings on emotional recognition with aligned and misaligned faces: when two face halves are aligned and display the same expressions, observers demonstrate higher accuracy and shorter reaction times (i.e., holistic facilitation; Calder et al., 2000; Wegryn et al., 2015).

While these results provide preliminary evidence that interrupting holistic processing may enhance observers’ ability to detect incongruence in emotional facial expressions, cautious interpretations are warranted. First, participants were asked, “As an attempt to look happy, how genuine does this expression look to you?” While consistent with the contextual prompt participants were given in the study instructions, this question format may confound participants’ recognition of happiness with perceptions of facial expression genuineness. In other words, given the instructions provided, it is unclear whether participants were rating targets’ level of happiness (or lack of anger), or the genuineness of those expressions. Also, while the pilot study displayed faces until participants responded, previous research has limited presentation duration in composite face task to be fixed between 500–1000ms (see meta-analysis, Richler & Gauthier, 2014). Although it appears that holistic interference occurs rapidly (e.g., Richler et al., 2012;
Tanaka et al., 2012), longer presentation durations such as 1200ms may eliminate holistic interference effects, presumably because participants can voluntarily engage in a part-based processing style (Calder et al., 2000; Hole, 1994). Since both holistic interference and disfluency effects appear to occur on a short time course (e.g., Tanaka et al., 2012; Winkielman et al., 2015), a better test might present face stimuli for a fixed, shorter duration.

Additionally, the pilot study manipulated emotional expression incongruence in the upper (but not lower) face. Namely, anger appeared in the upper face only. While this manipulation mimics previous research (e.g., Calvo et al., 2012; Tanaka et al., 2012), it is important to consider how incongruence in the lower face may affect observers’ judgments of facial expression genuineness. For example, Calvo and Fernández-Martín (2012) found that the eye region is influenced by the expression conveyed by the mouth in incongruent composite faces, but that a smile produced a larger influence than a sad or angry mouth did. If interrupting holistic processing enhances observers’ ability to detect facial expression incongruence, this should be the case whether the apparent incongruence is in the upper or lower face. Thus, I revised the Pilot Study procedures to generate Study 1, in light of these considerations.
Chapter Three: Study 1

Method

Participants and Design

Participants \((n = 96, 77 \text{ females}, 23 \text{ males})\) were initially recruited from the University of Denver participant pool \((M_{\text{age}} = 19.60, SD_{\text{age}} = 1.33, \text{ range} = 18–23)\). This sample was composed of White (62.96%), mixed-race (11.11%), Hispanic (12.04%), Asian (1.85%), Native American (1.85%), and Black (1.85%), and 8.34% preferred not to say. A 2 (Alignment: aligned, misaligned) \(\times\) 2 (Emotional Congruence: congruent, incongruent) within-subjects design was used. Twenty-one participants did not complete the study. The smallest effect detected in the Pilot study was \(\eta^2 = 0.38\), a large effect. A sensitivity power analysis indicated that with a sample size of \(n = 75, 128 \text{ trials, and } \rho =.50\) among trials, we had 95% power to detect an effect as small as \(\eta^2 = .07\), which is considered a medium effect by Cohen (2013) standards.

Stimuli

Study 1 used the same target faces (Mihalache et al., 2021; Tottenham et al., 2009) as in the Pilot study. However, the following changes were made to address the limitations of the Pilot study. In contrast to the Pilot study, which only manipulated emotional congruence and incongruence in the upper face (i.e., anger in the upper face only), Study 1 manipulated emotional incongruence in the upper and lower face. Specifically, \textit{emotionally congruent} faces featured either anger or happiness in both the
upper and lower face. *Emotionally incongruent* faces are those that feature either anger in the upper face with happiness in the lower face, or vice versa (see Figure 4). Thus, both possibilities of emotional incongruence (i.e., upper anger/lower happy; upper happy/lower angry) were included. While the Pilot study used three levels of emotional intensity (20%, 40%, 60%), Study 1 simplified the design with two levels of intensity (20%, 60%). Like the Pilot Study, every possible combination of emotional intensity and emotion was used to create stimuli. The manipulation of holistic processing was the same as the Pilot study: each face was presented either *aligned*, wherein the faces halves create an intact composite, or *misaligned*, wherein the faces were horizontally misaligned with a 30% offset. Like the Pilot study, a thin black line was inserted in between the upper and lower face at the middle of the nose (Gray et al., 2017; Rossion & Retter, 2015). In total, 128 stimuli faces were used. Again, each target presented every possible combination of aligned and misaligned congruent and incongruent expressions, reducing the possibility that extraneous factors (e.g., facial attractiveness) could explain observers’ genuineness ratings.

*Figure 4.* Example incongruent stimuli used in Study 1. In the top row, an aligned (left) and misaligned (right) face with anger at 60% intensity in the upper face and happiness at 60% intensity in the lower face. In the bottom row, an aligned (left) and misaligned (right) face with happiness at 60% intensity in the upper face and anger at 60% intensity in the lower face.
Procedure

Like the Pilot study, participants first completed a demographic questionnaire, indicating their age, gender, ethnicity, undergraduate major, whether English is their native language, whether there was any reason to not use their data, if they were currently under the influence of any substances that might impair their ability to complete the study, how tired they were before the study (1 - not at all to 4 - very tired), how they are feeling (1 - very poor to 4 - very well), and whether there is anything else that might affect their performance. Participants were then redirected to a webpage to complete the primary study, detailed below.

Initial Instructions. Participants were informed that facial expressions may not reflect genuine emotion but can be faked or posed. Specifically, they were told that a genuine expression occurs when somebody displays a facial expression and feels that emotion internally, whereas a fake expression occurs when someone displays a facial expression but does not feel that emotion internally. They were then told that during the study, they would be rating how genuine various facial expressions looked to them. Thus, in contrast to the Pilot study, they were not cued to focus on the upper or lower half of the face and were not told what emotion the expresser intended to communicate. Rather, participants were simply asked to evaluate the genuineness of the expression presented. Instructions were as follows:

In the following study, you will be rating facial expressions. Sometimes facial expressions reflect genuinely felt emotion, but other times expressions are faked or posed (e.g., to be polite). An example of a genuine expression is when somebody smiles and they really feel happy, like when they get a present or see something funny. An example of a faked expression is when somebody smiles without feeling any emotion, or to cover up another emotion they actually feel. For example, people may choose to cover up feelings of anger by expressing a
more socially-appropriate emotion, like happiness, instead. For the following facial expressions, you will rate how genuine they look.

**Practice Trials.** Prior to beginning the primary experiment, participants were presented with examples (a target not used in the primary study), which included a face that was aligned and misaligned. Participants then rated the face they had just seen on a scale from -7 (completely fake) to +7 (completely genuine) with the prompt, “*How genuine did that expression look to you?*” (Dawel et al., 2017; Miolla et al., 2021).

**Primary Experiment.** Each trial began with a fixation cross at the center of the screen for 500ms. Participants were then presented with a target face for 500ms. Participants were then prompted on the next screen, “*How genuine did that expression look to you?*” and indicated their response on a scale from -7 (completely fake) to +7 (completely genuine) (see Figure 5). Participants completed each of the 128 trials in random order.

**Additional Judgments.** After the primary task, participants were also asked how difficult they found the task on a scale from 1 (very easy) to 5 (very difficult) ($M = 2.44$, $SD = 1.04$, $n = 25$), provided a dichotomous judgment of which face type made it easier to detect genuineness (aligned: 92%, misaligned: 8.00%, $n = 25$), and completed an open-ended question about whether they had any guesses for what the primary experiment was about. Lastly, participants were thanked for their participation and debriefed.

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4 Like the Pilot Study, many participants did not complete the follow-up questions after the primary experiment.
Figure 5. One example trial in Study 1. A fixation cross was displayed for 500ms, followed by a face for 500ms, and then a response screen without the face displayed until participant response.

Results

A 2 (Alignment: aligned, misaligned) × 2 (Congruence: congruent, incongruent) within-subjects ANOVA was performed on observers’ ratings of genuineness. Results revealed a main effect of alignment, \( F(1, 78) = 6.75, p = .011, \eta_p^2 = .08 \). Specifically, misaligned faces (\( M = -0.17, SD = 3.80 \)) were rated as less genuine than aligned faces (\( M = 0.48, SD = 3.91 \)). Results also revealed a main effect of congruence, \( F(1, 78) = 39.20, p < .001, \eta_p^2 = .33 \). Specifically, incongruent faces (\( M = -0.12, SD = 3.81 \)) were rated as less genuine than congruent faces (\( M = 0.43, SD = 3.91 \)). There was not, however, an alignment × congruence interaction, \( F(1, 78) = 0.01, p = .91 \) (see Figure 6). To test the

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5 See Appendix B for additional analyses that also include emotion type and emotional intensity as independent variables. Critically, these variables did not interact with alignment, \( ps > .129 \).
focal hypothesis, Bonferroni-corrected post-hoc tests were conducted. For incongruent faces, misaligned faces ($M = -0.44, SE = 0.19$) were rated as less genuine than aligned faces ($M = 0.20, SE = 0.15$), $t(78) = 2.48, p = .015, d = 0.28$, consistent with the hypothesis that disrupting holistic processing may improve detection of cues to deception on the face. For congruent faces, misaligned faces ($M = 0.10, SE = 0.20$) were also rated as less genuine than aligned faces ($M = 0.75, SE = 0.17$), $t(78) = 2.54, p = .013, d = 0.29$.

**Figure 6.** The effect of emotional congruence and alignment on observers’ mean ratings of genuineness in Study 1. Error bars represent ± 1 standard error.

**Discussion**

The pattern of results observed in Study 1 bear both similarities and differences from those observed in the Pilot study. In both studies, I found that incongruent expressions were rated as less genuine when misaligned (vs. aligned), consistent with the hypothesis that interrupting holistic processing would improve the detection of emotional congruence (Calder et al., 2000; Calvo et al., 2012; Calvo, Fernández-Martín, et al., 2013; Tanaka et al., 2012). This pattern results do not appear to support the hypothesis
that mixed expressions result in subjective disfluency, serving as a cue to deception in the
evaluation of emotional facial expression genuineness (Olszanowski et al., 2018;
Winkielman et al., 2015). If so, aligned (vs. misaligned) incongruent expressions would
have been rated as less genuine. However, congruent expressions were rated as more
genuine when misaligned (vs. aligned) in the Pilot study, while the opposite effect was
found in Study 1. Specifically, Study 1 found that both congruent and incongruent
expressions were rated as less genuine when misaligned compared to aligned. Thus, the
results of Study 1 suggest that misaligning faces generally decreases their genuineness
ratings, irrespective of their emotional congruence.

Like the Pilot Study, the effect of alignment on congruent expressions was
unexpected. One possibility is that misaligned (vs. aligned) faces are perceived as less
familiar, bizarre, or untrustworthy when making ratings of genuineness. Ratings of
genuineness on a continuous scale in the present research differ from previous research
using similar paradigms wherein the task is typically emotion recognition accuracy on a
dichotomous scale (e.g., Calder et al., 2000; Tanaka et al., 2012). Another possibility is
that for congruent expressions, aligned (vs. misaligned) faces result in holistic
facilitation, as previous research has found that when two faces halves are aligned and
show the same expression, participants demonstrate higher emotion recognition accuracy
and faster reaction times (Calder et al., 2000; Wegrzyn et al., 2015; White, 2000). It is
possible that gains in accuracy and speed conferred from holistic facilitation are lost
when congruent faces are misaligned and therefore interrupt holistic processing.
Conversely, misaligning incongruent faces reduces holistic interference among the face
halves, resulting in greater accuracy and reaction time (e.g., Calder et al., 2000; Tanaka et
al., 2012). In other words, holistic processing facilitates the perception of emotional congruence, whereas interrupting holistic processing facilitates the perception of emotional incongruence.
Chapter Four: Study 2

The aim of Study 2 was to extend and further explore the findings of the Pilot Study and Study 1 by investigating whether disrupting holistic processing would affect observers’ ability to detect emotional expression genuineness with a set of real and spontaneous genuine and deceptive (posed) expressions. The Pilot study and Study 1 are both limited in that they use artificially produced stimuli; it is not clear whether the effects observed in either study would be generalizable to real (and posed) emotional facial expressions. For example, Namba et al. (2018) had participants discern whether targets were showing and feeling a given emotion for facial expressions of amusement, disgust, sadness, and surprise. Results indicated that genuine expressions were evaluated as more felt than posed expressions. Using stimuli with greater ecological validity would result in a more generalizable test of the current competing hypotheses. Accordingly, in Study 2, a new set of stimuli featuring real and posed expressions of happiness and anger were used. Additionally, we explore the effect of instruction and emotion type (happy, anger) on observers’ ratings of genuineness. Specifically, since happiness is associated with higher levels of trust and anger with lower levels of trust (Oosterhof & Todorov, 2008), these emotional expressions may have different effects on observers’ perceived genuineness (Centorrino et al., 2015).
Method

Participants and Design

Participants ($n = 76$, 67 female, 6 male, 4 non-binary) were recruited from the University of Denver and received course credit for their participation ($M_{age} = 19.24$, $SD_{age} = 0.99$, range = 18–22). The sample was composed of White (57.69%), Hispanic (21.80%), mixed-race (8.97%), Asian (5.13%), Black (1.28%), Indian (1.28%), and 2.56% preferred not to say. Study 2 used a $2$ (Veracity: genuine, posed) $\times 2$ (Emotion: happiness, anger) $\times 2$ (Alignment: aligned, misaligned) $\times 3$ (Block: randomized, happiness, anger) within-subjects design. A sensitivity power analysis indicated that with a sample size of $n = 76$, 208 trials, and $\rho = 0.5$ among trials, we had 95% power to detect an effect as small as $\eta^2 = .07$, which is considered a medium effect by Cohen (2013) standards.

Stimuli

The Padova Emotional Dataset of Facial Expressions (PEDFE) was used for facial expression stimuli (Miolla et al., 2021). The PEDFE features fifty-five targets displaying genuine ($n = 707$) and posed ($n = 751$) facial expressions of the six basic emotions. The PEDFE has several advantages over other stimuli sets. Namely, each of the six emotions is displayed genuinely and posed for each target, each elicited with a total of fifteen emotion tasks for the six basic emotions. Moreover, all stimuli were validated by asking targets to rate each clip according to the emotion, genuineness, and intensity of their facial expression. All distracting variables from the background (e.g., hair, clothes) have been removed from each stimulus (see Figure 7). Stimuli were also
rated by a separate set of observers, who were asked to identify the emotion displayed, whether it was genuine or fake, and how intense the expression appeared.

Figure 7. Peak intensity images of genuine (top row) and simulated (bottom row) expressions of six emotions included in the PEDFE. Adopted from Miolla, Cardaioli, and Scarpazza (2021).

Targets were filmed with a hidden camera and a laptop webcam while watching emotional videos (i.e., emotion elicitation tasks) while alone in a room and were asked to rate the emotional valence of videos. As a cover story, targets were told that the webcam was recording eye movements and pupil dilation while performing the valence rating task. After completing several emotion elicitation tasks, targets identified which emotion they felt, rated how genuine the emotion was from -7 (completely not genuine) to +7 (completely genuine), and how intense the emotion was from 0 (none) to 9 (strong). Videos of genuine expressions were then chosen only if both the emotional expression matched FACS coding criteria and targets’ self-reports (e.g., experienced happiness with a high level of genuineness). Videos of posed expressions were created after the emotion elicitation tasks. Specifically, participants were asked to pose each of the six basic emotions several times with different intensity modulations.
**Stimuli Selection.** First, targets \((n = 55)\) displaying genuine expressions of happiness \((n = 214)\), posed expressions of happiness \((n = 156)\), genuine expressions of anger \((n = 76)\), and posed expressions of anger \((n = 90)\) were initially considered for inclusion. Expressions of happiness and anger only were selected to conceptually map on to the Pilot Study and Study 1. However, some of the stimuli were not filmed from a frontal view. As mentioned above, targets were filmed with a hidden camera or a laptop webcam. Manipulating holistic processing by misaligning the face would not be possible for images filmed from a non-frontal view. Consequently, a research assistant first coded whether targets were filmed from a frontal view \((n = 265\) expressions) or not \((n = 271\) expressions). This resulted in 38 unique targets with a frontal view and the following number of expressions: genuine happiness \((n = 105)\), posed happiness \((n = 94)\), genuine anger \((n = 27)\), and posed anger \((n = 27)\). Some targets had several genuine and posed expressions of happiness and anger. For example, one target had five expressions of genuine happiness, four expressions of posed happiness, five expressions of genuine anger, and four expressions of posed anger. To maintain consistency across emotion and veracity conditions, targets \((n = 13)\) were selected if they had at least one of each type of expression: genuine happiness, genuine anger, posed happiness, posed anger. For targets who had several versions of a given expression, one was randomly selected.

Since expression stimuli were originally in video form, a static image for each expression was chosen. To choose a static image of each expression for each target, a research assistant and I independently coded a range of video frames that depicted the emotional expression being displayed at full intensity. Specifically, we independently indicated at which video frame the peak intensity emotion began and ended, thus creating
a range of frames to subsequently choose from. Initially, the range we each independently indicated overlapped for 90.38% of expressions. For the remaining 9.62% of expressions where the range did not overlap, videos ($n = 5$) were independently evaluated again and subsequently indicated overlapping ranges. For each expression, a single frame was chosen from the overlapping ranges of peak intensity coding. Thus, for each of the thirteen targets, one frame of each emotion (happy, anger) and veracity (genuine, posed) was chosen for a total of 52 images. Consequently, since each expresser provided two genuine and two posed expressions of happiness and anger, extraneous factors that might affect observers’ ratings of genuineness (e.g., gender, attractiveness) were held constant across genuine and posed stimuli.

**Manipulating Holistic Processing.** Original images were considered ‘aligned’, and a 30% offset was used to create horizontally misaligned versions of each expression. A thin black line was inserted in between the upper and lower half of the face at the middle of the nose of all stimuli faces (Gray et al., 2017; Rossion & Retter, 2015). Thus, there were 52 aligned faces and 52 misaligned faces for a total of 104 face stimuli (see Figure 8).

Figure 8. Example stimuli used in Study 2. In the top row, an aligned (left) and misaligned (right) face genuine expression of happiness. In the bottom row, an aligned (left) and misaligned (right) posed anger.

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6 Disagreement for this set of targets appeared to be because the targets displayed a peak intensity facial expression more than once during the video.
Stimuli Manipulation Check. With a final set of thirteen unique targets, each displaying one version of genuine happiness, genuine anger, posed happiness, and posed anger, a manipulation check was conducted to determine if genuine expressions were previously rated as more genuine than posed expressions. Specifically, all stimuli were rated by a separate set of observers, who were asked to identify the emotion displayed, whether it was genuine or fake, and how intense the expression appeared as part of the PEDFE database (Miolla et al., 2021). An independent samples t-test revealed that genuine expressions ($M = 1.78, SD = 1.52$) were previously rated as more genuine than posed expressions ($M = -1.18, SD = 2.43$), $t(50) = 5.29, p < .001, d = 0.74$.

Procedure

After providing informed consent, participants completed the same demographic questionnaire as the Pilot Study and Study 1. Participants were then redirected to a webpage to complete the primary study. First, participants were told that they would be rating facial expressions. In contrast to the Pilot Study and Study 1, instructions were:

Sometimes facial expression reflect genuine felt emotions, but other times expressions are faked or posed. A genuine expression is when somebody displays the emotion they feel internally. A fake expression is when somebody displays an emotion but does not feel that emotion internally. For the following expressions, you will be rating how genuine or fake they look.

Practice Trials. Participants were shown then shown examples (of a target not used in the primary study) of an aligned and a misaligned face. Then, they were then shown those same faces for 500ms each and asked to rate them on a scale of -7 (completely fake) to +7 (completely genuine), with the prompt, “How genuine did that expression look to you?”. Participants then proceeded to the primary experiment, where
they completed the randomized block and then the happy block and angry block (or vice versa) as described below.

**Primary Experiment.** After the two practice trials, participants began the primary experiment. Specifically, each participant began with a *no context block* that presented all faces \((n = 104)\) in random order. Unlike the previous experiments, each trial did not begin with a fixation point. Since these stimuli were not videotaped from a consistent or systematic distance for each participant, a fixation cross would not always appear at the center of the face. Instead, after a 500ms delay, a face was shown for 500ms and then participants were asked to rate each face on a scale from -7 (*completely fake*) to +7 (*completely genuine*), with the prompt, “How genuine did that expression look to you?”. Each of the 104 faces were presented in random order. Participants could spend as much time as they needed on each trial to make their judgments, but the face was not present after 500ms (see **Figure 9**). After completing the randomized block, participants completed the *happy block* and the *angry block* in randomized order. In the happy block, participants were told: “In the next part of the study, you will be rating expressions of happiness. Specifically, you will be rating how genuine or fake each expression of happiness looks.” Participants then completed the same procedure as the randomized block for each of the happy faces only \((n = 52)\). Likewise, in the angry block, participants were told, “In the next part of the study, you will be rating expressions of anger. Specifically, you will be rating how genuine or fake each expression of anger looks.” Participants then completed the same procedure as the randomized block for each of the angry faces only \((n = 52)\).
Figure 9. Example of one trial in Study 2. A blank screen was presented for 500ms, followed by a face for 500ms, then a response screen until participant response.

**Additional Judgments.** After the randomized, happy, and angry blocks, participants were asked how difficult they found the experiment on a scale from 1 (*very easy*) to 5 (*very difficult*) \((M = 2.00, SD = 0.78, n = 11)\), to indicate which face type made it easier to detect genuineness (aligned: 100%, misaligned: 0%, \(n = 11\)), and to indicate any guesses for the study (open response). Participants were then thanked for their participation and debriefed.

**Results**

**No Context Block.** A 2 (Veracity: genuine, posed) \(\times\) 2 (Alignment: aligned, misaligned) within-subjects ANOVA was performed on observers’ ratings of genuineness.\(^7\) Results revealed a main effect of veracity, \(F(1, 74) = 21.09, p < .001, \eta_p^2 = \)

\(^7\) See Appendix C for analyses of observers’ reaction times to making genuineness ratings.
 Specifically, genuine expressions ($M = 0.49, SE = 0.06$) were rated as more genuine than posed expressions ($M = 0.04, SD = 0.06$). Results also revealed a main effect of alignment, $F(1, 74) = 5.43, p = .023, \eta^2_p = .07$. Specifically, aligned faces ($M = 0.40, SE = 0.06$) were rated as more genuine than misaligned faces ($M = 0.14, SE = 0.06$). There was not, however, a veracity $\times$ alignment interaction, $F(1, 74) = 0.18, p = .677, \eta^2_p = .002$ (see Figure 10). Although the interaction was not significant, Bonferroni-corrected post-hoc tests were performed to assess the hypothesis that for posed expressions, misaligned (vs. aligned) faces would be rated as less genuine. Results revealed that for posed expressions, misaligned faces ($M = -0.10, SE = 0.09$) were rated as less genuine than aligned faces ($M = 0.19, SE = 0.09$), $t(74) = -2.29, p = .025$. In contrast, for genuine expressions, aligned faces ($M = 0.61, SE = 0.09$) were not rated differently from misaligned faces ($M = 0.37, SE = 0.09$), $t(74) = -1.82, p = .073$.

Figure 10. The effect of veracity and alignment on observers’ mean ratings of genuineness in the no context block of Study 2. Error bars represent ± 1 standard error.
**Happy Block.** In the happy block, participants were told to rate how genuine or fake each expression appeared for happy faces only. A 2 (Veracity: genuine, posed) \( \times \) 2 (Alignment: aligned, misaligned) within-subjects ANOVA was performed on observers’ ratings of genuineness, revealing as main effect of veracity, \( F(1, 74) = 13.13, p < .001, \eta^2_p = .15 \). Specifically, genuine expressions of happiness (\( M = 1.45, \ SE = 0.08 \)) were rated as more genuine than posed expressions of happiness (\( M = 1.10, \ SE = 0.08 \)). There was no main effect of alignment, \( F(1, 74) = 1.85, p = .178, \eta^2_p = .02 \), nor a veracity \( \times \) alignment interaction, \( F(1, 74) = 1.35, p = .249, \eta^2_p = .02 \) (see Figure 1).

**Anger Block.** In the happy block, participants were told to rate how genuine or fake each expression of anger looks for angry faces only. A 2 (Veracity: genuine, posed) \( \times \) 2 (Alignment: aligned, misaligned) within-subjects ANOVA was performed on observers’ ratings of genuineness, revealing a main effect of veracity, \( F(1, 74) = 34.59, p < .001, \eta^2_p = .32 \). Specifically, genuine angry faces (\( M = -0.26, \ SE = 0.08 \)) were rated as more genuine than posed angry faces (\( M = -1.26, \ SE = 0.08 \)). Results did not reveal a main effect of alignment, \( F(1, 74) = 0.01, p = .925 \), nor a veracity \( \times \) alignment interaction, \( F(1, 74) = 0.39, p = .533 \) (see Figure 1).
Figure 11. The effect of veracity and alignment on observers’ mean ratings of genuineness in Study 2 for the randomized block (left panel), happy block (middle panel), and angry block (right panel). Error bars represent ± 1 standard error.

Discussion

The purpose of Study 2 was to investigate whether interrupting holistic processing would affect observers’ ratings of facial expression genuineness with a set of genuine and deceptive (posed) expressions. Consistent with the Pilot Study and Study 1, posed expressions were rated as less genuine when misaligned (vs. aligned), as would be predicted by the holistic processing hypothesis. However, Study 2 also found that genuine expressions that were misaligned (vs. aligned) were rated as less genuine, conceptually replicating the results from Study 1. Overall, the pattern of results from Study 2 closely mimics the pattern of results from Study 1: misalignment generally decreased observers’ ratings of genuineness.

Additionally, Study 2 added two additional blocks to the primary experiment block to explore whether instructions and emotion type would impact observers’
genuineness ratings. Each of the basic emotions may be visually processed differently, as each differs in which features are most salient or distinctive (Calvo et al., 2014; Calvo & Nummenmaa, 2008). The saliency of a feature (e.g., a smile) can bias the interpretation of other parts of the face when the face is aligned (Calvo, Fernández-Martín, et al., 2013). Moreover, since happiness and anger are associated with higher and lower levels of trust, respectively (Oosterhof & Todorov, 2008; Zebrowitz et al., 2013), these emotional expressions may consequently have different effects on observers’ perceived genuineness (Centorrino et al., 2015).

In the happy block, observers rated genuine expressions as more genuine than posed expressions, but there was no effect of face alignment nor an interaction between veracity and face alignment. This appears to indicate that all happy expressions were rated as at least somewhat genuine, regardless of veracity or face alignment. Likewise, in the angry block, observers rated genuine expressions as more genuine than posed expressions but there was no effect of face alignment nor an interaction between veracity and face alignment. Granted, statistical power was lower in these blocks (with fewer trials) than the no context block, and visual inspection of the means suggests that there may well be differences across these emotion conditions if a higher-powered study was conducted. Another striking difference is the mean genuineness rating of all happy and all angry faces; all happy faces (even the posed expressions) were well above 0, while ratings of all angry faces were below the 0 mid-point. This appears to indicate that angry faces overall were rated as somewhat disingenuous, regardless of veracity or face alignment. Taken together, this pattern of results for the happy and angry block seems to
suggest a valence effect for these facial expressions: happy expressions are rated as more genuine than angry expressions, regardless of veracity or face alignment.

This is consistent with previous research, finding that more positively valenced (e.g., happy) faces are rated as more trustworthy, whereas negatively valenced (e.g., angry) faces are rated as less trustworthy (Todorov et al., 2008). Interestingly, for both the happy and angry blocks, no effect of alignment was observed. In other words, interrupting holistic processing by misaligning faces, whether genuine or posed, did not affect genuineness ratings, in contrast to the holistic processing hypothesis. Additionally, the disfluency hypothesis was not supported, as misaligned (vs. aligned) posed expressions were rated as less genuine.
Chapter Five: General Discussion

A growing body of evidence suggests that genuine facial expressions differ from deceptive facial expressions (Dopson et al., 1984; Ekman & Friesen, 1982; Hess & Kleck, 1990; ten Brinke et al., 2012). However, previous work on observers’ deception detection accuracy of emotional facial expressions is mixed, with some studies indicating above chance performance (e.g., McLellan et al., 2010) and others indicating chance performance (e.g., Evanoff et al., 2016). In a series of studies, the present work aimed to test competing hypotheses to explain why accuracy in detecting deceptive emotional facial expressions may be poor.

On the one hand, since people process faces holistically (Piepers & Robbins, 2012) and rapidly attend to specific regions of the face when an emotion is expressed (Calvo, Fernández-Martín, et al., 2018), one region of the face may interfere with or bias observers’ perception of other regions (e.g., Calvo et al., 2013; Elsherif et al., 2017). Indeed, previous work has demonstrated that deceptive facial expressions of emotion typically involve incongruence among the upper and lower halves of the face (ten Brinke & Porter, 2012b). Consequently, observers may be fooled by the simulated facial actions of a deceptive actor (e.g., Zloteanu et al., 2019). However, previous work has demonstrated that interrupting holistic processing by misaligning the face results in higher accuracy in detecting an emotion expressed in one region of the face with less interference from the other regions of the face, particularly when the irrelevant region of
the face is incongruent with the target region (Calder et al., 2000; Tanaka et al., 2012). Since there is evidence that deceptive facial expressions involve leakage that occurs either in the upper or lower half of the face (Porter et al., 2012; Porter & ten Brinke, 2008), interrupting holistic processing may increase observers’ ability to detect incongruence among the face halves by reducing holistic interference and the biasing effect that one half of the face has on the other. In other words, interrupting holistic processing allows observers to evaluate the degree of incongruence among face halves, as they can be evaluated independently.

On the other hand, a separate line of research on social impressions of mixed facial expressions—artificially produced full-faced blends of different emotions—suggests that these faces are rated as less attractive and less trustworthy compared to their non-mixed counterparts, an effect that is mediated by observers’ subjective experience of processing disfluency (Olszanowski et al., 2018; Winkielman et al., 2015). These findings suggest that observers’ subjective disfluency from mixed faces—which are conceptually similar to the incongruent appearance of deceptive facial expressions—could serve as a potential cue to deception when evaluating emotional facial expression veracity. The current set of studies tested these two alternative hypotheses to explain why previous deception detection accuracy performance is mixed for emotional facial expressions. If disrupting holistic processing enhances observers’ ability to detect incongruence among face halves, it would be expected that incongruent or deceptive faces would be rated as less genuine when misaligned than aligned. In contrast, if holistic processing facilitates the subjective experience of disfluency, serving as a cue to
deception, it would be expected that incongruent or deceptive expressions would be rated as less genuine when aligned compared to misaligned.

Across all the present studies, observers rated incongruent (Pilot Study, Study 1) and posed (Study 2) expressions as less genuine when misaligned compared to aligned. Thus, the current set of studies does not appear to support the idea that subjective disfluency arises from aligned incongruent (Pilot Study, Study 1) or posed expressions (Study 2), leading to lower ratings of genuineness relative to misaligned incongruent or posed expressions. Instead, results are consistent with the idea that by interrupting holistic processing, observers could better evaluate the degree of incongruence among the face halves to inform their genuineness ratings. Indeed, this pattern of results emerged for both artificially created (Pilot Study, Study 1) and real genuine and posed (Study 2) expressions. This interpretation, however, is complicated by the findings for congruent (Study 1) and genuine (Study 2) expressions, wherein misaligned faces were rated as less genuine than aligned faces. This finding was unexpected and contrasts with previous research using similar composite-face paradigms: either there is no difference in accuracy in emotion recognition for aligned compared to misaligned congruent faces (e.g., Tanaka et al., 2012), or there is an effect of holistic facilitation—greater accuracy and shorter response times—for aligned compared to misaligned congruent faces (e.g., Calder et al., 2000; Wegrzyn et al., 2015; White, 2000).

While the consistent effect for both Study 1 and Study 2 of misalignment decreasing genuineness ratings for both congruent/genuine and incongruent/posed expressions was unexpected, there are a few possibilities for why this occurred. First, the task itself is arguably qualitatively different from previous work that has used dependent
measures of emotion recognition (Calder et al., 2000; Tanaka et al., 2012). To my knowledge, no other studies have used a composite face paradigm with a dependent measure of genuineness or another comparable construct (c.f., Todorov et al., 2010). It is possible that when making judgments of genuineness, misaligned faces are perceived as bizarre or unusual. Relatedly, research on processing fluency—the ease with which an observer can interpret or comprehend a message—influences evaluations of information as true, familiar, frequent, or attractive (e.g., Dechêne et al., 2010; Reber & Schwarz, 1999). For example, when participants are judging the truthfulness of messages in videos where the audio and video channels are slightly offset (vs. not), there is a decrease in the processing fluency of the message, resulting in participants doubting the truthfulness of the message, even though all of the verbal and nonverbal information is unchanged (ten Brinke & Weisbuch, 2020). Likewise, in the current set of studies, it is possible that misaligned compared to aligned faces in the current studies not only disrupted holistic processing but also processing fluency, incurring negative evaluations from observers. Although processing fluency was not directly measured, participants in the current studies were asked whether aligned or misaligned faces made it easier to detect genuineness, and overwhelmingly indicated that maligned faces made it more difficult.

**Limitations and Future Directions**

In addressing these competing hypotheses, the current studies had several limitations. Since misalignment impacted both congruent/genuine and incongruent/posed expressions, it remains unclear whether disrupting holistic processing enhances observers’ ability to detect incongruence. While interrupting holistic processing, misaligning faces may also induce subjective disfluency in observers if the task is to
identify genuineness. Accordingly, it is difficult to disentangle whether effects of misalignment on veracity judgments are due to disrupting holistic processing or are artifacts of subjective disfluency. Alternatively, future research may instead employ a manipulation of processing that does not distort faces in a manner that elicits subjective disfluency. For example, previous research has explored whether priming participants with a local (i.e., part-based) or global (i.e., holistic) processing orientation increases recognition of emotional facial expressions (Martin et al., 2012). Specifically, prior to displaying each facial expression, they used a Navon letter task, where figures are composed of letters that are either consistent (e.g., an S composed of smaller Ss) or inconsistent (e.g., a S composed of Ts). They were instructed to direct their attention to either the global or local form of the letters and subsequently presented with a brief display of an emotional facial expression. They found that when primed with a local (vs. global) processing orientation, participants were modestly more accurate (2%) and faster at emotion recognition. Future research may investigate whether such a manipulation of processing orientation would be effective in discerning genuine from deceptive facial expressions of emotion, changing the processing orientation of the stimuli observers perceive rather than the stimuli themselves. Moreover, if observers were indeed more accurate in discerning genuine from deceptive expressions when using a local (vs. global) processing orientation, this would have more practical utility and ecological validity than the misalignment of faces.

Additionally, it is possible that explicit instruction to compare the upper and lower face when making genuineness judgments could have enhanced the effect of interrupting holistic processing for incongruent and deceptive expressions. For example,
Boutet, Lemieux, Goulet, & Collin (2017) examined whether task instructions would alter fixations when discriminating whether two rapidly shown faces were the same or different (upright or inverted). Faces had either configural changes (i.e., the relational distances among face parts) or featural changes (e.g., different eyes). When participants were unaware of what information would be relevant for the task, face processing was dominated by fixation to the eyes. In contrast, when participants were informed that relational information among the face parts was relevant for the task, participants directed the majority of their fixations to the center of the face. Consequently, performance was enhanced when participants were aware of what information would be relevant to the task. In other words, participants’ visual attention strategies appeared to be driven by task demands. Similarly, in Study 2, a happy and anger block was included to investigate how emotion type and instructions could impact genuineness ratings. In the happy block, observers rated genuine happy expressions are more genuine than posed expressions, but there was no effect for alignment. Likewise, in the anger block, genuine anger expressions were rated as more genuine than posed expressions, with no effect of alignment. This pattern of results suggests that instructions or context impacts observers’ judgments of genuineness, but it is unclear what strategies they used or if their visual attention differed compared to the initial no context block.

Another limitation is that across all studies, observers were asked to rate how genuine the expression appeared to them. In the Pilot Study, it is unclear whether observers were rating targets’ level of happiness (or lack of anger), or the genuineness of those expressions. Indeed, even in Study 1 and Study 2, it is possible that features related to the expressions displayed—happiness and anger—influenced observers’ genuineness
ratings. For example, Olszanowski et al. (2018) found that trust judgments of mixed (i.e., disfluent) expressions were influenced by facial features related to valence but not social motivation (i.e., approach, avoid). Specifically, pure happy (vs. sad) expressions were judged as more trustworthy, whereas pure sad (vs. angry) expressions were judged as more trustworthy. Interestingly, mixed happy–sad expressions (vs. pure expressions) were judged as relatively less trustworthy, whereas mixed angry–sadness expressions (vs. pure expressions) were not. Taken together, this suggests that judgments of trust for disfluent expressions are more likely to be influenced by valence-related (vs. motivation-related) information. Similarly, Del Libano et al. (2018) found that the strongest predictor of discrimination performance between happy and non-happy incongruent expressions was affective valence—observers’ ratings of how emotionally positive or negative the expressions appeared to be.

Consequently, it is critical for future research to consider other operationalizations of the dependent variable that reduce the potential conflation between positively valenced features of the face and genuineness ratings. Indeed, this is a difficult task as positive trait judgments in person perception are strongly correlated with trust judgments (Oosterhof & Todorov, 2008). However, Namba et al. (2018) presented participants with genuine and posed emotional expressions and asked participants to indicate whether a target was showing a given emotion and whether a target was feeling a given emotion. Results revealed that genuine (vs. posed) expressions were rated more as felt for all presented expressions. This procedure allows participants to separately rate the degree to which the ostensible emotion is displayed and the degree to which the emotion is internally experienced by the target, potentially reducing the influence of positively valenced
features. Relatedly, while the present series of studies focused on the positively valenced expression of happiness and the negatively valenced expression of anger, which have diagnostic regions in the lower and upper face, respectively (Calvo, Fernández-Martín, et al., 2018; Schurgin et al., 2014), future research should consider other emotional expressions that vary on valence, visual saliency, and distinctiveness of features (e.g., Calvo et al., 2014; Smith et al., 2005; Wegrzyn et al., 2015).

Future research should also investigate whether observers’ visual attention differs when viewing genuine compared to deceptive expressions. To my knowledge, only one study has examined visual attention during a deception detection task. Bond (2008) explored whether we could identify lie detection ‘experts’ and if so, to study their detection behavior using eye-tracking. He found two individuals—correctional officers—who scored 80–90% accurate on veracity judgments across two video sets. These two experts’ ocular movement data revealed that at the time of the veracity judgment, one expert focused more on the face, whereas the other looked more at the arm and torso areas. Unfortunately, further analyses of what nonverbal (i.e., facial, torso, and arm) behaviors were evident during these experts’ judgments were not provided. In other words, while we know where these experts were looking at the time of judgment, we do not know what occurred on the face or body of targets that contributed to veracity judgments.

More broadly, Cavlo, Fernández-Martín, Gutiérrez-García, and Lundqvist (2018) investigated ocular behavior on diagnostic regions for dynamic emotional facial expressions, finding that each of the basic emotions follow specific visual scanpath profiles. Specifically, the eye region was looked at earlier and longer for angry and sad
faces, the mouth region earlier and longer for happy faces, the nose and cheek region for
disgust, and a balance of viewing time of the eye and mouth regions for surprise and fear.
Other work has demonstrated that gaze allocation is biased toward diagnostic face
regions (e.g., Schurgin et al., 2014), and that increased visual attention to diagnostic
facial features is correlated with improved recognition performance (Wong et al., 2005).

It is currently unknown whether visual attention as measured by ocular behavior
would be different for deceptive compared to genuine expressions. Given the perceptual
saliency of the mouth (e.g., Calvo et al., 2013), it is possible that during deceptive
displays where a felt emotion (e.g., anger) is masked with a smile, observers’ visual
attention is brought to the mouth region and fails to attend to the eye region, where
leakage is more likely to occur (Porter et al., 2012). Consequently, observers would
visually ‘miss’ the critical information in the upper region of the face that reveals the
underlying emotion (see also Iwasaki & Noguchi, 2016).

Additionally, there is reason to believe that observers may have different scanpath
patterns depending on the type of judgments they are making. For example, Calvo,
Krumhuber, and Fernandez-Martín (2018) examined the visual attention mechanism in
processing facial expression when participants are making judgments of happiness and
trustworthiness. While recording their eye movement, participants saw dynamic faces
that began as neutral and morphed into congruent happy (happiness in the upper and
lower face) or incongruent happy (neutral eyes and smiling mouth), subsequently judging
how happy or how trustworthy the faces appear. Results revealed that the eye region was
the cue observers used in making trustworthiness judgments, whereas the mouth was the
cue used for making happiness judgments (see also Calvo, Gutiérrez-García, et al., 2013).
In other words, scanpaths in judgments of genuineness may differ from judgments of emotion displayed (i.e., emotion recognition), and there may be other differences between scanpaths for genuine compared to deceptive expressions. This work may reveal additional visual mechanisms, such as attentional processes, not explored in the current work that may better explain why detecting deceptive facial expressions of emotion is generally poor.

**Conclusion**

I argue that visual perception plays an important role in the process of deception detection and that greater consideration of how people visually process faces may help to explain why subtle cues to deception are not used by observers to make more accurate veracity judgments. The current series of studies investigated two competing hypotheses—the holistic processing hypotheses and the subjective disfluency hypothesis—that could explain why deceptive detection accuracy of emotional facial expressions is mixed. Across all studies, the subjective disfluency hypothesis was not supported. While support was garnered for the holistic processing hypothesis, cautious interpretations are warranted, as interrupting holistic processing decreased ratings of genuineness for both genuine and deceptive facial expressions of emotion. Future research should continue to consider how people visually process faces and its impact on their veracity judgments.
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Appendix A

The Effect of Emotional Intensity on Genuineness Ratings

In the Pilot Study, there was a significant alignment × congruence interaction, wherein for congruent expressions, misaligned (vs. aligned) faces were rated as more genuine, whereas for incongruent expressions, misaligned (vs. aligned) faces were rated as less genuine. Since congruent and incongruent expressions varied by intensity (20%, 40%, 60%) in the upper and lower face as well as alignment, I further explored whether emotional intensity and alignment interact. Namely, I examined whether there was an alignment × emotional intensity interaction when the upper and lower face had the same emotional intensity (e.g., 20% upper face intensity, 20% lower face intensity) for congruent and incongruent expressions.

Congruent Expressions: Matched Intensity

A 2 (alignment: aligned, misaligned) × 3 (emotional intensity: 20%, 40%, 60%) within-subjects ANOVA was performed on observers’ genuineness ratings of congruent expressions. Results revealed a main effect of alignment, $F(1, 66) = 11.10$, $p < .001$, $\eta^2_p = .14$. Misaligned faces ($M = 1.27$, $SE = 0.18$) were rated as more genuine than aligned faces ($M = 0.82$, $SE = 0.19$). Results also revealed a main effect of emotional intensity, $F(1.36, 90.07) = 174.27$, $p < .001$. Bonferroni-corrected post-hoc tests revealed that each emotional intensity differed significantly from one another (all pairwise $t$s $> 10.64$, all $ps < .001$), where congruent faces displaying 60% intensity ($M = 3.03$, $SE = 0.23$) were
rated as more genuine than faces displaying 40% intensity ($M = 1.07, SE = 0.19$), which were rated as more genuine than faces displaying 20% intensity ($M = -0.97, SE = 0.22$). There was not, however, an alignment $\times$ emotional intensity interaction, $F(1.98, 130.73) = 0.16, p = .852$ (see Figure 12).

**Incongruent Expressions: Matched Intensity**

A 2 (alignment: aligned, misaligned) $\times$ 3 (emotional intensity: 20%, 40%, 60%) within-subjects ANOVA was performed on observers’ genuineness ratings of incongruent expressions. Results did not reveal a main effect of alignment, $F(1, 66) = 0.31, p = .582$. There was a main effect of emotional intensity, $F(1.64, 108.56) = 50.21, p < .001, \eta_p^2 = .43$. Bonferroni-corrected post-hoc tests revealed that all pairwise comparisons were significantly different (all $t$s $> 3.71$, all $ps < .001$), where incongruent faces displaying 60% intensity ($M = -3.54, SE = 0.25$) were rated as less genuine than faces displaying 40% intensity ($M = -2.16, SE = 0.20$), which were rated as less genuine than faces displaying 20% intensity ($M = -1.50, SE = 0.21$). This main effect, however, was qualified by an alignment $\times$ emotional intensity interaction, $F(2, 131.99) = 3.32, p = 0.39$. Bonferroni-corrected post-hoc tests revealed that all pairwise comparison differed significantly except for aligned incongruent faces displaying 20% intensity ($M = -1.54, SE = 0.24$) compared to aligned incongruent faces displaying 40% intensity ($M = -2.27, SE = 0.20$), $t(66) = 2.36, p = .064$ (see Figure 12).
Figure 12. The effect of emotional intensity and alignment on observers’ genuineness ratings for congruent expressions (left panel) and incongruent expressions (right panel). Emotional intensity across comparisons is matched among the upper and lower face (e.g., 20% upper face, 20% lower face). Error bars represent ± 1 standard error.

The Effect of Congruence and Alignment on Reaction Time

A 2 (Alignment: aligned, misaligned) × 2 (Emotional Congruence: congruent, incongruent) within-subjects ANOVA was performed on observers’ reaction times. First, reaction times that were ± three standard deviations were excluded (1.98% of trials). Results revealed a main effect of alignment, $F(1, 66) = 7.60, p = .008, \eta^2_p = .10$. Specifically, observers spent longer on aligned ($M = 5.47$ sec, $SE = 0.25$) compared to misaligned ($M = 5.14$ sec, $SE = 0.20$) faces. There was no main effect of congruence, $F(1, 66) = 0.16, p = .693$, nor an alignment × congruence interaction, $F(1, 66) = 0.21, p = .647$ (see Figure 13).
Figure 13. The effect of congruence (columns) and alignment (rows) on observers’ reaction times (in seconds) when making genuineness ratings in the Pilot Study. Note: Reaction times ± 3 standard deviations have been excluded.
Appendix B

In Study 1, results revealed that there was not an alignment \times congruency interaction. It was explored whether this interaction could be qualified by emotional intensity (20% or 60%). Specifically, I explored whether subtle expressions (20% in the upper and lower face) evidenced a different pattern of results compared to strong expressions (60% in the upper and lower face). In other words, it is possible that interrupting holistic processing enhances the detection of emotional incongruence for subtle (vs. strong) expressions.

**Subtle Expressions**

A 2 (Alignment: aligned, misaligned) \times 2 (Emotional Congruence: congruent, incongruent) within-subjects ANOVA was performed on observers’ genuineness ratings for subtle expressions (i.e., 20% intensity in the upper and lower face). Results revealed a main effect of alignment, $F(1, 78) = 19.19, p < .001$. Specifically, aligned faces ($M = 2.01, SE = 0.22$) were rated as more genuine than misaligned faces ($M = 0.83, SE = 0.26$). There was not a main effect of congruence, $F(1, 78) = 1.37, p = .246$, nor an alignment \times congruence interaction, $F(1, 78) = 0.27, p = .606$ (see Figure 14).

**Strong Expressions**

A 2 (Alignment: aligned, misaligned) \times 2 (Emotional Congruence: congruent, incongruent) within-subjects ANOVA was performed on observers’ genuineness ratings for subtle expressions (i.e., 60% intensity in the upper and lower face). Results did not
revealed a main effect of alignment, $F(1, 78) = 1.08, p = .302$. There was, however, a main effect of congruence, $F(1, 78) = 42.13, p < .001$. Specifically, incongruent expressions ($M = -1.62, SE = 0.16$) were rated as less genuine than congruent expressions ($M = -0.07, SE = 0.21$). Results did not reveal an alignment $\times$ congruence interaction, $F(1, 78) = 0.03, p = .869$ (see Figure 14).

Figure 14. The effect of alignment and congruence on observers’ genuineness ratings for subtle expressions (left panel) and strong expressions (right panel). Subtle expressions were 20% intensity in the upper and lower face. Strong expressions were 60% intensity in the upper and lower face. Error bars represent $\pm 1$ standard error.

The Effect of Congruence and Alignment on Reaction Time

A 2 (Alignment: aligned, misaligned) $\times$ 2 (Emotional Congruence: congruent, incongruent) within-subjects ANOVA was performed on observers’ reaction times. First, reaction times that were $\pm$ three standard deviations were excluded (0.11% of trials).

Results revealed no main effect of alignment, $F(1, 78) = 0.40, p = .530$, no main effect of
congruence, $F(1, 78) = 0.81, p = .372$, nor an alignment × congruence interaction, $F(1, 78) = 0.47, p = .496$ (see Figure 15).

Figure 15. The effect of congruence (columns) and alignment (rows) on observers’ reaction times (in seconds) when making genuineness ratings in Study 1. Note: Reaction times ± 3 standard deviations have been excluded.
Appendix C

The Effect of Veracity and Alignment on Reaction Time

A 2 (Alignment: aligned, misaligned) × 2 (Veracity: genuine, posed) within-subjects ANOVA was performed on observers’ reaction times. First, reaction times that were ± three standard deviations were excluded (0.27% of trials). Results revealed no main effect of alignment, $F(1, 74) = 0.14, p = .711$, no main effect of veracity, $F(1, 74) = 0.00, p = .949$, nor an alignment × congruence interaction, $F(1, 78) = 0.42, p = .520$ (see Figure 16).

![Figure 16](image.png)

*Figure 16.* The effect of veracity(columns) and alignment (rows) on observers’ reaction times (in seconds) when making genuineness ratings in Study 2. Note: Reaction times ± 3 standard deviations have been excluded.