

LITERATURE REVIEW

Male and Female Differences in Nonconscious Mimicry: A Systematic Review

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Previous research on nonconscious mimicry suggests that females mimic their communication partners more often than males. Many studies have investigated the association between mimicry, emotion recognition, and empathy. However, there is a trend in this research area to recruit same-sex samples, thus neglecting a discussion regarding the role of sex or gender as a moderator of nonconscious mimicry. This article reviews the research on nonconscious mimicry – facial, behavioural, and verbal, in order to identify whether or not there are male and female differences. The results indicate that mimicry may be moderated by participant sex or gender depending upon, among others, choice of mimicry measurement, stimulus exposure length, and social context. However, few studies address male and female differences in mimicry and many have methodological limitations. The review concludes with a discussion and recommendations for future research.

Keywords: mimicry; sex; gender; emotion; culture

Previous research suggests that individuals instinctively mirror their communication partner's facial expressions (Hess & Bourgeois, 2010), behavioural gestures (Tschacher, Rees, & Ramseyer, 2014), and speech inflections (Sun, Truong, Pantic, & Nijholt, 2011) in order to enhance interpersonal understanding and rapport. Even in a laboratory setting, exposure to pictures of emotional facial expressions generates specific facial electromyographic (EMG) activity. More specifically, pictures of angry faces have shown to increase participants' corrugator muscle response, i.e. the muscles responsible for creating a frown; similarly, pictures of happy faces increase participants' zygomatic muscle activity, i.e. the muscles responsible for the formation of a smile (Dimberg, 1982). This natural tendency for individuals to reproduce the facial, behavioural, and vocal expressions of others is referred to as mimicry. Mimicry is usually defined as an unconscious and automatic process; furthermore, evidence of this process in new-born babies and other animals indicates that mimicry is an innate, adaptive, social behaviour (Estow, Jamieson, & Yates, 2007; Iacoboni, 2009).

Literature surrounding mimicry is extensive; however, although existing studies have focused on the functions and outcomes of mimicry, little has been done in relation to the investigation of sex or gender differences. The present literature review begins with an introduction to the functions and outcomes of mimicry and the

link between mimicry and empathy. Research evidence suggesting a potential male-female division in mimicry will then be presented, along with an outline of the implications that such a divide may have for the existing literature. Following the introduction to the literature, results of articles that attend to sex or gender in their analyses will be presented, with a subsequent discussion of the results and future recommendations for researchers.

Functions and Outcomes of Mimicry

The capacity and propensity for humans to mimic each other has long been of interest to both researchers and lay-people alike (CosmoGirl!, 2004; Lakin, Jefferis, Cheng, & Chartrand, 2003). Social psychology has suggested that mimicry has beneficial effects for all relationships and serves as a social glue, creating and reinforcing interpersonal bonds (van Baaren, Holland, Kawakami, & van Knippenberg, 2004). One study conducted by Zajonc, Adelman, Murphy, and Niedenthal (1987) reported that married couples' facial expressions become more similar overtime. It is argued that this similarity in appearance is due in part to the couple's frequent, nonconscious mimicry of each other's facial expressions. In addition, mimicry is thought to play an important role in infant social and emotional development. For instance, Haviland and Lelwica (1987) reported that by the age of ten weeks, an infant will mimic their mother's joyful and angry facial expressions. This developmental stage is of great social importance as the ability to mimic facial expressions is intimately connected to the ability to understand emotion, and

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so the ability to empathise with others (Blairy, Herrera, & Hess, 1999).

Mimicry and Emotion Recognition

This connection between facial mimicry and empathy was first proposed by Lipps (1907), who suggested that the replication of another's facial expression induces the experience of that emotion in the individual themselves, thus allowing the individual to feel how their communication partner is feeling. To date, many studies have been inspired by the Matched Motor Hypothesis (MMH) (Hess & Fischer, 2013) and the Facial Feedback Hypothesis (FFH) (Buck, 1980). MMH proposes that the mere perception of other's facial expressions will elicit a similar expression in that of the observer (Hess & Fischer, 2013). FFH proposes that facial movement can influence emotional experience (Buck, 1980; Kraut, 1982).

Laird (1974) examined the link between facial movement and emotional states by asking participants to tighten specific facial muscles which would result in either a frown or a smile, and thereafter, assessed their mood. In support of FFH, participants were more likely to rate their mood as happier when they adopted a smile, and angrier when pulling a frown. Similarly, while watching cartoons, Strack, Martin, and Stepper (1988) asked participants to hold a pen in their mouth in ways that either inhibited or enabled muscles typically associated with smiling. The researchers found that participants rated the cartoons as more humorous when the pen did not interrupt their ability to smile than when it did. Fusing the propositions of both MMH and FFH, Oberman, Winkielman, and Ramachandran (2007) tested whether blocking their participant's ability to mimic, via pencil biting or chewing gum, would interrupt their ability to recognise emotion. Their results showed that when the ability to mimic the emotional expression of another is blocked, this impairs the participant's ability to identify emotions. The results of such studies support Lipps' (1907) argument that facial mimicry is an important component in emotion recognition.

Comparing Male and Female Mimicry

As exemplified by a recent critique of the simulation of smiles model (Simpson & Fragaszy, 2010), one prominent issue within the field of mimicry is the lack of consideration of male and female differences. In line with the comments made by Simpson and Fragaszy (2010), the current review suggests that there are two main stances from which one can expect males and females to differ in mimicry behaviour. The first of these involves the biological differences between males and females, the second involves the impact of gender socialisation on facial and behavioural expression.

Biological sex. Beginning with the facial regions involved in the expressions surprise, sadness, happiness, and disgust, previous research has identified that, compared to females, males exhibit larger movements in the upper brow and forehead region (Sforza, Galante, Shirai, & Ferrario, 2010), the mouth corner region, and the upper

lip region (Giovanoli, Tzou, Ploner, & Frey, 2003) even when controlling for facial size (Clark Weeden, Trotman, & Faraway, 2001). These results suggest that men should have more pronounced reactions to the aforementioned emotions.

Additionally, in recent years neuroscience has argued for the involvement of mirror neurons in mimicry. Mirror neurons have been described as a distinct set of neurons that discharge when humans and animals view the motor movements of others, it is suggested that these neurons may facilitate mimicry (Acharya & Shukla, 2012). Research in this field has identified that females recruit areas of the brain containing mirror neurons to a higher degree than males (Schulte-Rüther, Markowitsch, Shah, Fink, & Piefke, 2008), and further still, that these regions are anatomically and functionally different for males and females, suggesting that males and females may use different cognitive emotional processing strategies which may contribute to the observed sex differences in mimicry (Cheng et al., 2009; Yamasue et al., 2008).

A third argument for potential sex differences in mimicry comes from a study of spinal activation while viewing body movements. Comparing the spinal excitability level of males and females observing video recordings of bipedal-heel stepping, standing still, and bipedal-toe stepping, Cheng et al. (2007) discovered that females show higher levels of spinal excitability modulation than males, meaning females had a stronger impulse to mimic the observed motor movements compared to males.

The final argument commonly used to suggest sex differences in mimicry comes from research on the impact of testosterone on emotional competence. We already know that men have higher baseline testosterone levels than women (Baron-Cohen, 2002) and that lower levels of testosterone have been found to predict pro-social behaviour in both men and women (Harris, Rushton, Hampson, & Jackson, 1996); therefore, Hermans, Putman, and van Honk (2006) tested the causality of the association between testosterone level and emotional mimicry by manipulating the testosterone levels of female participants. The results revealed that administration of a single dose of testosterone significantly decreased females' emotional facial mimicry. Results reached highest significance in the *corrugator supercilii* muscles (frowning) and the *zygomatic major* muscles (smiling). Self-report measures of mood states did not reveal any effect of testosterone administration indicating that the subtle effects of a single dose of testosterone were not consciously noticed by participants. These results suggest that as a result of having higher baseline testosterone levels, males should mimic to a lesser extent than females.

In summary, the research findings presented above collectively argue for sex differences in mimicry based on male and female biological differences in the varying regions currently believed to be related to mimicry. The results presented suggest that while males may show more pronounced facial reactions to certain emotions, females should mimic the facial and behavioural movements of others to a greater extent than males. However,

only considering biological sex ignores the potentially more imposing effect of gender socialisation.

Gender socialisation. Despite the abundance of research on biological sex differences in relation to mimicry, research examining differences between males and females have more often discussed their results in terms of gender. In comparison to sex – the biology of being male or female, gender refers to the societal roles and expectations attributed to men and women; and whilst the two terms, sex and gender, are often interconnected, the effects that biological sex and gender socialisation have on mimicry may differ (Phillips, 2005). For this reason, it is important to discuss and consider both sex and gender when investigating male and female differences in mimicry.

In many cultures, stereotypical gender norms paint strongly contrasting images of men and women. The portrayal of the ideal woman usually encompasses the terms gentle, empathetic, joyful, and compliant; yet, the adjectives more commonly used to describe men include courageous, aggressive, self-reliant, and domineering (Prentice & Carranza, 2002). This dichotomous socialisation of men and women may trickle down into human nonconscious behaviours such as mimicry, which could alter the expected differences between males and females established on the biological level.

For instance, in contrast to some of the findings related to biological sex, previous research focusing on gender have established that women tend to be more facially expressive than men (Buck, Savin, Miller, & Caul, 1972) and have more pronounced facial reactions to emotional facial expressions than men (Berenbaum & Rotter, 1992). It is thought that these differences observed between men and women are connected to stereotypical gender norms. In that, stereotypical gender norms, as outlined above, place more importance on women's recognition of emotion than men's (Hess & Bourgeois, 2010). In an attempt to examine the role of gender socialisation, Buck (1977) investigated how gender expectations may affect young children. It was found that preschool boys from four to six years of age tended to inhibit and mask their own emotional facial responses to a greater extent than girls of the same age. Thus, it can be argued that the contrasting societal expectations for men and women in relation to emotion expression may have an impact on their level of mimicry from a young age.

Interestingly, although emotional display rules tend to differ somewhat cross-culturally, the acceptability for men and women to show 'soft' or 'strong' emotions appears to remain constant. Safdar et al. (2009) compared the emotional display rules for seven different emotions in three different cultural groups: Canadians, Americans, and Japanese. Their research indicated that while cross-cultural norms in relation to the display of emotion varied between North American and Japanese participants, in all groups it was more acceptable for men to express powerful emotions such as anger, contempt, and disgust; and more acceptable for women to display less powerful emotions such as happiness, fear, and sadness. No differences

were found for the display of surprise. From these results, it can be argued that male and female differences in facial mimicry may depend on which type of emotion is being observed.

A final argument suggesting gender differences in behavioural mimicry stems from feminist literature on women and men's occupation of space. In addition to personality and temperament related gender norms, stereotypical gender norms expand to regulate the scope and magnitude of male and female bodily movements e.g. hand gestures and leg movements (Young, 1980). For instance, in line with the expectation for women to be gentle and compliant, women typically use much less space than men during interactions. This can be seen in the way that women are typically expected to sit with their limbs closed or crossed and arms held relatively close to their body. Contrastingly, it is acceptable for men to make use of more space than women by sitting with open limbs and keeping their arms held farther from their body (Wedgewood, 2004; Young, 1980). Although this would appear to be at odds with the predictions from biological sex, men's increased access to space may lead to more pronounced behavioural mimicry particularly when presented with more robust stimuli.

To sum up, gender poses restrictions on men and women's emotional and behavioural expression over and above that of biological sex. More specifically, while the biological argument states that males should have more pronounced facial reactions, according to societal and cultural gender display rules, this may only be the case for more powerful emotions such as anger, contempt, and disgust. In line with these same display rules, women should show more pronounced facial reactions to joy, sadness, and fear, but show less robust behavioural mimicry.

The Importance of Investigating Male and Female Differences

As mentioned earlier, many studies in the field of mimicry have not considered male and female differences, or have avoided the issue of sex and gender differences by recruiting female or male samples only – see **Figure 1**. From a research perspective, this is concerning; if there are significant differences between males and females, as suggested by the findings presented above, this would question the generalisability of the studies using female or male samples only. Furthermore, one could query whether the results of studies with opposite-sex samples could in fact be explained by sex or gender differences.

Aims and Objectives

In light of the lack of attention given to sex and gender within the literature in the field of mimicry, and the importance that both sex and gender differences may have for the design of future research, the aim of the present article is to review existing literature on nonconscious mimicry, identify whether or not there are differences in the mimicry behaviour of males and females, and examine what factors may explain the differences.

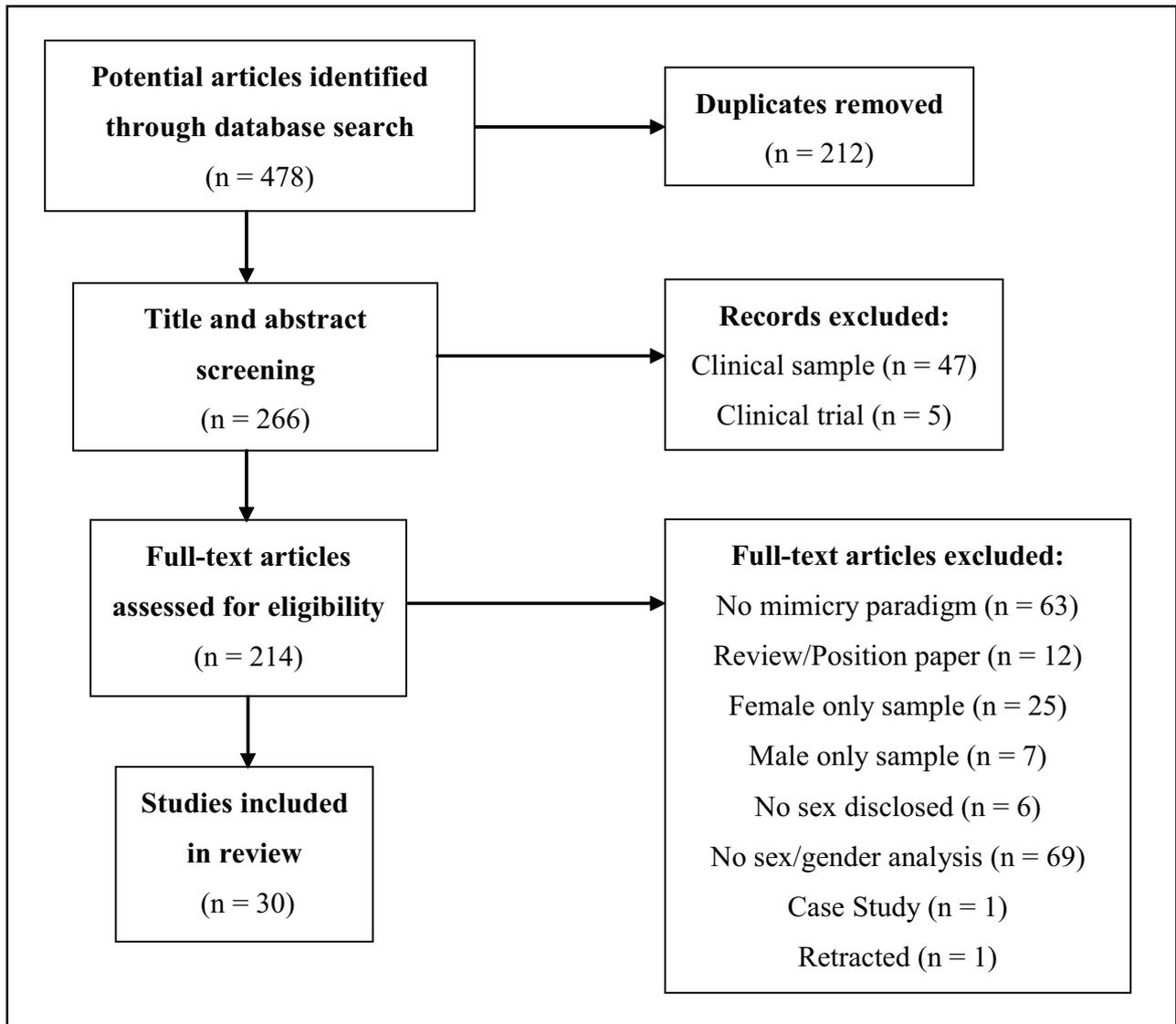


Figure 1: Article selection process.

Method

Literature Search

A search was conducted in October 2015 using the following databases: PsychInfo, PubMed, Web of Science, and Google Scholar. Articles were required to be written in English and published in peer-reviewed scientific journals. No publication date restrictions were applied. The search terms used were (“mimic” OR “mimicry”) AND (“emotion” OR “behavior” OR “behaviour” OR “facial”). Search results were screened for relevancy using title and abstract information. Remaining articles were then read through to determine inclusion ability. The article selection process is illustrated in **Figure 1**.

Inclusion and Exclusion Criteria

For the purpose of this article, studies had to include a spontaneous mimicry paradigm, report on the results of the mimicry paradigm, include both male and female participants, and report on sex or gender differences in mimicry. Given that a number of studies have shown that certain clinical populations mimic to a lesser extent than healthy controls (Berndl, von Cranach, & Grüsser, 1986;

Dethier & Blairy, 2012; McIntosh, Reichmann-Decker, Winkielman, & Wilbarger, 2006; Mergl, Mavrogiorgou, Hegerl, & Juckel, 2005) articles were excluded if the study results only reported on a specific clinical population.

Article Selection

The literature search of four databases produced 266 potentially relevant articles. Following the screening of titles and abstracts, articles using clinical samples or testing the efficacy of a clinical or neurological treatment were excluded. A total of 214 articles remained and were read thoroughly to assess for inclusion. Next 184 articles were excluded (see **Figure 1** for detailed exclusion explanations), resulting in a final total of 30 articles.

Results

Study Characteristics

Taking into consideration all of the articles identified in the database search that included a mimicry paradigm, only 22% reported the inclusion of sex or gender in their analyses. Of the final 30 articles, the type of mimicry and methodology varied considerably; nevertheless,

11 of these articles found some moderating effect of sex or gender. In line with previous research findings suggesting that mimicry can be affected by the nature and perceived authenticity of the stimuli (Krumhuber & Kappas, 2005; Rymarczyk, Biele, Grabowska, & Majczynski, 2011), articles have been grouped and are presented according to the stimulus type used in each study. A summary of the reviewed articles can be found in **Table 1**.

Photographic Stimuli

Eight studies used emotionally loaded photographs to assess facial mimicry. The earliest of these eight studies was conducted by Lundqvist and Dimberg (1995) who aimed to explore the relationship between facial mimicry and emotional contagion. The researchers used the pictures displaying anger, joy, fear, disgust, surprise, and neutrality (Ekman & Friesen, 1975a). Each image was presented for 8 s (seconds). Facial EMG activity was recorded via the *zygomaticus major* (joy – pulls lip corners up), *corrugator supercilii* (anger/fear – knits the brow), *Levator Labii Alesque Nasii* (sad/disgust – elevates upper lip and dilates nostril), and *Frontalis* (surprise – raises the brow) muscles. The results revealed no significant effect of participant sex; however, upon further exploration, a trend was identified indicating more facial mimicry of happy faces among female participants.

Blairy et al. (1999) tested whether nonconscious mimicry of emotional facial expressions can facilitate empathy. Photographs of joyful, angry, sad, disgusted, fearful, and neutral faces were selected (Matsumoto & Ekman, 1988). Participants' facial activity level was assessed using facial EMG readings from the *Corrugator Supercilii* (brow), *Orbicularis Oculi* (eye), and the *Levator Labii Alesque Nasii* (upper lip) muscles. Each emotional facial expression was presented for 10 s. The results revealed that participants did spontaneously mimic the expressions of those in the photographs; however, no significant sex differences were found.

Aiming to investigate the association between empathy and mimicry at differing processing levels, Sonnby-Borgström (2002) used photographs of angry, neutral, and happy faces (Ekman & Friesen, 1975b) which were shown at 14 different exposure times ranging from 17 ms (milliseconds) to 6 s. Facial EMG was used to measure muscle activity in the *Zygomaticus major* and *Corrugator Supercilii* regions. Participant gender had a significant effect on facial mimicry at the automatic processing level (17 – 30/40 ms) only.

In a later study by Sonnby-Borgström, Jönsson, and Svensson (2003), the researchers again investigated the association between empathy and mimicry at differing processing levels. Similar to the previous study participants were exposed to four happy and angry faces with a neutral image in between (Ekman & Friesen, 1975b). Exposure times were 17 ms, 56 ms, and 2,350 ms. Facial EMG was used to measure muscle activity in the *Zygomaticus major* and *Corrugator Supercilii* regions. In contrast to their previous results, no effect of gender was identified.

An attempt was made by Vrana and Gross (2004) to replicate the earlier findings of Dimberg (1982), who showed that viewing posed facial expressions elicits facial mimicry. Images of joyful, angry, and neutral facial expressions

(Ekman & Friesen, 1975a) were shown to participants for 8 s while facial movements were assessed via facial EMG data from the *zygomaticus major* and *corrugator supercilii* muscles. Although it was found that participants' mimicked the expressions in the photographs, no gender differences in facial movements for either muscle regions were identified.

Having previously found mixed results, in 2008, Sonnby-Borgström, Jönsson, and Svensson aimed to identify whether gender differences in facial mimicry related to differing stimulus exposure times. It was hypothesised that differing levels of information processing, from spontaneous (subliminal) to controlled (supraliminal), would differentially influence men and women's mimicry. Participants were exposed to images of faces expressing anger, joy, sadness, and neutrality, taken from Ekman and Friesen (1975b). Subliminal-level photos were presented for 23 ms, borderliminal for 70 ms, and supraliminal for 2,500 ms. Similar to the above study, Sonnby-Borgström and colleagues used facial EMG data from the *zygomaticus major* and *corrugator supercilii* muscles to measure participants' smiling and frowning expressions. An effect of exposure time was found, in that, while no gender differences in mimicry were identified at the subliminal or borderliminal exposure times, women showed larger responses than men to happy versus angry faces at the supraliminal exposure time.

In light of the evidence suggesting an effect of testosterone on mimicry and the 'Extreme Male Brain Theory' of autism (Baron-Cohen, 2002), Hermans, van Wingen, Bos, Putman, and van Honk (2009) investigated whether autistic traits would impair an individual's ability to mimic. Level of facial mimicry was compared among individuals with a probable autism-spectrum disorder and controls. In line with the inclusion criteria for this review, only results of the control group are presented. Photographs depicting joy and anger were selected from two databases (Ekman & Friesen, 1975a; Lundqvist, Flykt, & Öhman, 1998) and shown for 5 s each. Similar to the above studies, facial EMG data was collected from the *zygomaticus major* and *corrugator supercilii* muscles. The researchers defined mimicry as nonconscious if it occurred within 1,500 ms of stimulus exposure. Analyses revealed that women showed significantly higher levels of facial mimicry, as measured by the *corrugator supercilii* muscles, than men.

Finally, Rymarczyk et al. (2011) aimed to test whether dynamic faces of joy and anger could evoke higher intensity facial reactions than static faces depicting the same emotions. In accordance with the aim, this study used both photographic and video stimuli (Beaupré & Hess, 2005). Facial EMG data was collected from the *zygomaticus major* and *corrugator supercilii* muscles. Participants reacted spontaneously and rapidly to happy faces with increased *zygomaticus major* activity and decreased *corrugator supercilii* activity, showed greater changes in response to dynamic stimuli, but no significant gender effects were identified.

Video Stimuli

Thirteen studies used video recordings involving emotional expressions to assess nonconscious facial and behavioural mimicry. Bush, Barr, McHugo, and Lanzetta (1989)

Authors	Aim	Stimulus	Sample	Measure	Results
Lundqvist & Dimberg (1995)	To explore the association between facial mimicry and emotional contagion.	Photographs	28 males; 28 females	Facial EMG	A trend towards increased mimicry of happy facial expressions among females.
Blairy et al. (1999)	To examine whether nonconscious mimicry can facilitate empathy.	Photographs	15 males; 15 females	Facial EMG	No significant gender differences in facial mimicry were identified.
Sonnby-Borgström (2002)	To investigate the association between empathy and mimicry behaviour at different levels of processing	Photographs	21 males; 22 females	Facial EMG	Gender had a significant effect on mimicry only at the automatic processing level.
Sonnby-Borgström et al. (2003)	To examine how facial mimicry behaviour is related to emotional empathy at different levels of information processing.	Photographs	36 males; 34 females	Facial EMG	Males and females did not differ on level of mimicry.
Vrana & Gross (2004)	To test whether the viewing of emotional facial expressions elicits facial mimicry.	Photographs	10 males; 9 females	Facial EMG	No significant gender differences in facial mimicry were identified.
Sonnby-Borgström et al. (2008)	To identify whether sex differences in facial mimicry related to stimulus exposure length.	Photographs	51 males; 51 females	Facial EMG	Females mimicked happy photographic expressions to a greater extent than males at the supraliminal level (2.500ms).
Hermans et al. (2009)	To examine whether autistic traits impact facial mimicry.	Photographs	10 males; 6 females	Facial EMG	Females showed significantly higher levels of facial mimicry.
Rynarczyk et al. (2011)	To test whether dynamic faces would enhance facial reactions.	Photographs & Video	12 males; 15 females	Facial EMG	No significant gender effects were identified.
Bush et al. (1989)	To examine the impact of facial control on reactions to comedy routines.	Video	39 males; 34 females	Facial EMG	No gender differences in facial mimicry were identified.
Laird et al. (1994)	To explore the role of mimicry and self-perception processes in emotional contagion.	Video	Study 1: 18 males; 28 females. Study 2: 29 males; 28 females.	Coded observations	No gender differences in behavioural or facial mimicry were observed.
Estow et al. (2007)	To examine the role of self-monitoring in mimicry.	Video	17 males; 45 females	Coded observations	No gender differences in facial or behavioural mimicry were identified.
Stel et al. (2010)	To investigate whether a priori liking of an individual can influence mimicry of that person.	Video	9 males; 41 females	Coded observations	No effect of gender was identified.
Moody & McIntosh (2011)	To explore whether mimicry involves a motor-matching mechanism or an emotional processes.	Video	15 males; 22 females	Facial EMG	No effect of gender was identified.
Niedenthal et al. (2012)	To investigate the impact of pacifier use on mimicry and emotional competence.	Video	61 males; 45 females	Coded observations	Only boys mimicry was affected by pacifier use.
Stel et al. (2013)	To investigate the association between just world views and mimicry.	Video	23 males; 26 females	Coded observations	No gender differences in behavioural or facial mimicry were identified.

Contd.

Authors	Aim	Stimulus	Sample	Measure	Results
Soussignan et al. (2013)	To examine the impact of direct and averted gaze on facial mimicry.	Video	21 males; 21 females	Facial EMG	Men mimicked anger more than women; Women mimicked fear and sadness more than men.
Schneider et al. (2013)	To examine the influence of expressive suppression and mimicry on facial affect sensitivity.	Video	39 males; 57 females	Facial EMG	No gender differences were found.
Joyal et al. (2014)	To assess concomitants and construct validity of a newly developed set of virtual faces.	Video	20 males; 21 females	Facial EMG	No gender differences were identified.
Korb et al. (2014)	To investigate how people perceive different types of smiles and judge their authenticity.	Video	11 males; 20 females	Facial EMG	Males showed less AU6 and more AU12 activity when mimicking smiles than females.
Rauchbauer et al. (2015)	To investigate whether and how mimicry is modulated by social-affective variables.	Video	23 males; 18 females	fMRI	No gender differences were identified.
Cheung et al. (2015)	To investigate the interpersonal functions of facial mimicry after social exclusion.	Video	9 males; 13 females	Coded observations	Women and men did not differ on level of mimicry.
Chartrand & Bargh (1999)	To test the association between mimicry, liking, and empathy.	Interaction partner	39 male and female participants	Coded observations	No gender differences were observed.
van Baaren et al. (2003)	To test the prediction that self-construal orientation affects nonconscious mimicry.	Interaction partner	18 males; 33 females	Coded observations	No effects of gender were identified.
Karremans & Verwijmeren (2008)	To examine the association between mimicry and participant relationship status.	Interaction partner	31 males; 22 females	Coded observations	Women mimicked their interaction partners more so than men.
van Straaten et al. (2008)	To examine the role of mimicry in short-term mate preference.	Interaction partner	60 males; 59 females	Coded observations	Men mimicked pen playing more than women. Women mimicked postural shifting more than men.
Hess & Bourgeois (2010)	To investigate the role of emotional and social context on mimicry.	Interaction partner	Study 1: 48 male pairs; 48 female pairs Study 2: 72 opposite sex pairs	Coded observations & facial EMG	Men showed less mimicry than females in angry versus happy conditions.
Kulesza et al. (2014)	To examine and define verbal mimicry, and the link between verbal mimicry and prosocial behaviours.	Interaction partner	165 males; 165 females	Coded observations	No gender differences were identified.
Rueff-Lopes et al. (2015)	To explore the occurrence of vocal mimicry in a natural setting.	Interaction partner	Call centre employees (31 Female; 10 Male) Callers (754 Female; 213 Male)	Coded observations	Males showed more negative vocal mimicry while females showed more positive vocal mimicry.
Kurzban (2015)	To evaluate whether and how broader concepts of personality are related to mimicking behaviour.	Interaction partner	8 males; 24 females	Coded observations	No gender differences were observed.
Kurzban & Borkeanu (2015)	To explore the antecedents and consequences of mimicry, facial and behavioural, and the role of personality in a natural setting.	Interaction partner	92 males; 90 females	Coded observations	No effect of gender was identified.

Table 1: Articles investigating sex differences in nonconscious human mimicry.

examined facial mimicry during video recordings of comedy routines. The researchers were interested in the emotional expression and affective experience of participants. Videos included a series of 1–3 s captions of smiling or laughing audience members. Videos ranged from 160 s to 320 s with 8–10 s of audience member close-ups. Facial EMG activity was measured from the *corrugator supercilii*, *zygomaticus major*, and *orbicularis oculi* muscle regions on the left side of each participant's face. Analyses of facial mimicry data revealed no sex differences for any of the muscle regions.

Next, Laird et al. (1994) explored the role of mimicry and self-perception processes in emotional contagion across two experiments. In the first experiment, participants watched two video clips depicting a fearful situation. During this part of the study, the researchers coded the participants' bodily reactions in accordance with those in the video clip in order to assess behavioural mimicry. In the second experiment, participants watched three film clips of happy people. Experiment two was designed to assess facial mimicry. No sex differences in behavioural or facial mimicry were observed.

Estow et al. (2007) examined the role that self-monitoring plays in behavioural and facial mimicry. Participants were video-recorded while exposed to video clips (7 s) of people laughing, yawning, or frowning. Participants' behavioural recordings were independently coded by two experimenters. The results showed that although participants did mimic the actors' laughs, yawns, and frowns, no effect of participant sex was found in any of the analyses.

Given the pro-social nature of mimicry, Stel et al. (2010) wanted to investigate whether a priori liking of an individual could influence mimicry of that person. Before participants watched a 1 min video, they received background information about the individual in the video in order to induce liking or disliking for that individual. Conditions were organised into a like, dislike, or no-influence control condition. Observations were video recorded and coded for mimicry. Compared to controls, a priori liking increased mimicry while disliking showed no change. The results revealed no effect of gender in any of the analyses.

Moody and McIntosh (2011) aimed to explore the processes involved in rapid, subtle mimicry. Participants watched short videos of smiling, scowling, stuttering, and arm wrestling. Muscle activity was recorded using EMG from the *zygomaticus major*, *corrugator supercilii*, *orbicularis oris* (purses or compresses lips), *carpi radialis* and *flexor digitorum sublimis* muscles of the forearm (flexes forearm). Participants were found to mimic facial expressions only. No effect of gender was identified.

Acknowledging that there may be a gender divide in mimicry and emotional competence, Niedenthal et al. (2012) retrospectively investigated the impact of pacifier use on young boys' and girls' emotional development. The researchers recruited boys and girls averaging seven years of age. Each child was exposed to movies of happy facial expressions changing gradually to sad, or vice versa. Video recordings of the children's reactions were analysed independently by two coders. The results revealed that boys showed less mimicry compared to girls as a function of pacifier use.

In 2013, Stel and colleagues aimed to test whether participants' view of the world as just could be influenced by facial and behavioural mimicry and imitation. Part three of this study investigated participants' levels of spontaneous mimicry, thus only these results are presented. Participants were recorded watching a three-minute video wherein a student spoke about her thesis and internship experiences while naturally moving her head, eyes, eyebrows, mouth, lips, hands, and shoulders. Nonconscious mimicry was defined as mirroring the stimulus movements within 5 s of exposure. Mimicry was shown to influence just-world beliefs but no effects of participant sex were found.

Soussignan et al. (2013) aimed to test the effect of gaze direction on mimicry. Participants watched videos of avatars expressing the emotions joy, anger, sadness, and fear either directly at the participants or with a diverted gaze. Facial EMG readings were examined from four muscles: the *corrugator supercilii*, *zygomaticus major*, *lateral frontalis*, and *depressor anguli oris* (pulls lips down). Men showed higher levels of zygomatic activity in the direct as opposed to the averted gaze condition. Gaze direction did not affect women's zygomatic activity. However, no differences between women and men's happy facial mimicry was found. In the angry condition, men showed higher levels of *corrugator supercilii* activity when angry faces looked directly at them, and even more activity again when the avatar was male. Men mimicked more than women in the angry condition. In the fear condition, women reacted more than men to fearful faces with averted gaze. Finally, women displayed higher depressor activity than men when exposed to sad faces.

In an attempt to marry the stances of MMH and FFH, Schneider, Hempel, and Lynch (2013) examined the association between mimicry and facial affect sensitivity by randomising participants to one of three conditions (Suppress, Mimic, and No-Instruction). In each condition, participants viewed a series of six emotional expressions (joy, sadness, fear, anger, surprise, and disgust) as they morphed from neutral to full expression. Facial EMG readings were taken from the *Zygomaticus Major*, *Corrugator Supercilii*, and *Levator Labii* (retracts upper lip). In accordance with MMH and FFH, mimicry facilitated facial expression recognition, whereas mimicry suppression disrupted emotion recognition. Additionally, women were faster than men at identifying emotional expressions, particularly disgust and fear. However, no mimicry differences were observed between men and women in the EMG analysis.

Given that many studies are using virtual stimuli, Joyal, Jacob, Cigna, Guay, and Renaud (2014) aimed to test the validity of a set of virtual faces expressing six emotions (happiness, surprise, anger, sadness, fear, and disgust). Participants watched video clips depicting real vs. virtual adults expressing emotions. Facial EMG activity was monitored via the *Zygotmaticus Major* and the *Corrugator Supercilii* muscles. Similar levels of activation were observed for real and virtual faces; however, no sex differences were identified.

Korb, With, Niedenthal, Kaiser, and Grandjean (2014) investigated how people perceive different types of smiles

and judge their authenticity. Participants observed short videos of smiles while their facial mimicry was measured with EMG over four facial muscle regions: *Corrugator Supercilii*, *Orbicularis Oculi*, *Zygomaticus Major*, and *Masseter* (drops jaw). Smile authenticity was judged after each trial. Mimicry enhanced authenticity ratings. Results were similar for males and females with the exception of less AU6 activity and more AU12 activity in males, this indicates that women may show more Duchenne smiles than men.

More recently, Rauchbauer, Majdandžić, Hummer, Windischberger, and Lamm (2015) aimed to investigate whether and how mimicry is modulated by social-affective variables. Participants watched videos of finger movements accompanied by facial expressions above the hand stimulus. They were instructed to lift one finger once they could see the number 1 and another when they could see the number 2. Videos of finger movements were congruent or incongruent to the request. This study was designed to assess behavioural mimicry of finger movement. Mimicry was assessed by examining differences between reaction times in incongruent and congruent trials for each condition. Data was analysed using Functional magnetic resonance imaging (fMRI). Results were better overall in congruent trials; however, men and women did not differ on level of mimicry.

Lastly and most recently, Cheung, Slotter, and Gardner (2015) investigated the interpersonal functions of facial mimicry after social exclusion. Participants played an online game called *cyberball* in which they were included or excluded by 'other' players and were, thereafter, required to watch a 2 min emotional video clip. In this study, facial mimicry was defined as the similarity of valence and intensity of emotional expressions between interaction partners. Video recordings of the participants were coded for facial expressiveness. Participants did mimic more in the excluded condition; however, no main effects or moderation by gender was identified.

Interaction Partners

Nine studies assessed participants' mimicry level while conversing with another person. The earliest of which was conducted by Chartrand and Bargh (1999). The aim of this study was to test whether participants would automatically mirror the behaviour of their interaction partner, and whether the interaction partner's mimicry could influence level of liking and empathy between the partners. Participants took part in 10 min video-recorded interactions in which their task was to describe photographs. Four confederates were trained to use specific behaviours during the interactions such as face rubbing, foot shaking, and changing facial expressions. Interactions were video-recorded and coded for analyses. Women and men equally mimicked smiles more when the confederate smiled, shook their feet more when with the foot-shaking confederate, and touched their faces more when with the face-touching confederate.

The next study using interaction partners was conducted by van Baaren, Maddux, Chartrand, de Bouter, and van Knippenberg (2003). Participants were required to interact with a confederate while taking part in a scrambled

sentence task, during which the confederate picked up and put down a pen several times. All interactions were video-recorded and subsequently coded to assess level of behavioural mimicry. Mimicry of pen-playing did occur; however, no significant effects of gender were found. The researchers noted that they expected to find gender differences but believe that significance was not reached as they did not have sufficient statistical power to test such a model.

Mimicry has long been thought to play a role in seduction (Wodak, 1989); therefore, Karremans and Verwijmeren (2008) were interested in the role that participants' relationship status has on their level of mimicry when conversing with attractive opposite-sex others. Participants with differing relationship statuses were interviewed for four minutes by an attractive confederate who would regularly touch his/her face. All interactions were recorded and behavioural mimicry (face touching) was coded by two independent raters. The results revealed that women tended to mimic their interaction partners more than men. There was no interaction of sex and relationship status, meaning, the sex differences observed in mimicry were not subject to relationship status differences.

van Straaten, Engels, Finkenauer, and Holland (2008) were also interested in the connection between mimicry and romantic relationships. More specifically, the researchers investigated sex differences in short-term mate preference and behavioural mimicry (nonconscious mimicry of gestures, bodily movements, and behaviours) according to social status and level of attractiveness. A naturalistic social environment was created by designing a laboratory in the form of a pub. Similar to the above study, the researchers paired participants with a confederate of the opposite sex. Confederates were divided by the researchers into low and high *perceived attractiveness*, and were provided with cover job titles reflecting high or low *social status*. Each pair's interactions were video-recorded while watching 20 min of commercials. All confederates were instructed to behave naturally, make eye contact with the participant, and engage in frequent pen-playing movements. Nonconscious mimicry was defined as occurring within 10 s after stimulus exposure. Unfortunately, van Straaten et al. (2008) did not conduct a sex analysis on frequency of mimicry. However, they did report the mean scores for males and females separately on level of mimicked pen playing and postural shifting. These scores indicate that men mimicked the pen-playing of their confederates more so than women, but women mimicked the postural shifts of their confederates more so than men. Although there appear to be sex differences, an interaction between participant sex and mimicry condition was found, in that, women were more likely to mimic the pen-playing behaviour of their interaction partner if their partner's perceived social status was higher. Similarly, men were more likely to mimic the postural movements of their interaction partners if their partners were perceived as highly attractive.

Given the importance of social context in human mimicry, Hess and Bourgeois (2010) investigated how emotional and social context may differentially impact male and females level of mimicry. Hess and Bourgeois (2010)

conducted two experiments, the first with same-sex pairs and a second with opposite-sex pairs. Each pair played an emotional card-based story-telling game. In addition to video recordings, facial muscle activity was measured on the left side of the face, using data from the *Orbicularis Oculi*, *Zygomaticus Major*, *Corrugator Supercilii*, and *Levator Labii Aleaque Nasii* muscles. Interactions lasted on average 183 s. The results of “experiment one” revealed that women tended to smile more than men, men mimicked less in angry compared to happy emotional conditions, and women were not affected by context. The researchers then conducted the same study with opposite-sex pairs. “Experiment two” interactions lasted on average 185 s. Again, the results revealed that men’s mimicry of smiles was subject to emotional context, in that, men showed less mimicry of opposite sex interaction partners during angry compared to happy narratives, whereas women mimicked to the same extent in both conditions. Results in experiment two, i.e. opposite-sex pairs, were generally weaker than experiment one, i.e. same-sex pairs.

Having noticed a gap in the literature on mimicry, Kulesza, Dolinski, Huisman, and Majewski (2014) aimed to: 1) examine and define verbal mimicry, and 2) examine the link between verbal mimicry and prosocial behaviours. This study was set in a currency exchange office. Participants were randomly assigned to one of five conditions (three experimental and two control groups) differentiated by the cashier’s verbal responses. Verbal recordings provided evidence of verbal mimicry and its importance in the creation of positive verbal interactions, nevertheless, no gender differences were identified.

Rueff-Lopes, Navarro, Caetano, and Silva (2015) also investigated verbal mimicry. The aim was to explore the occurrence of vocal mimicry in a natural setting. In a private room at an inbound call centre, two trained researchers listened randomly to 967 live phone calls between customers and employees. Negative vocal mimicry was the mimicry of negative emotion between caller and receiver. Positive vocal mimicry was the mimicry of positive emotion between caller and receiver. The results of their analyses showed that males showed increased levels of negative vocal mimicry compared to females, while females showed increased levels of positive vocal mimicry when compared to males.

Bringing the research on verbal mimicry more closely in line with that of facial and behavioural, Kurzius (2015) evaluated whether and how personality is related to verbal mimicry. Participants interacted with two confederates who differed in speech rate (slow, fast). Mimicry was measured via a participant’s adaptation to the confederate’s speech rate. Speech rates in each condition were measured as words uttered per minute of speaking. Extraversion and openness significantly predicted speech rate adjustment; however, no effect of gender was found.

Keeping with a focus on personality, Kurzius and Borkenau (2015) aimed to explore the antecedents and consequences of mimicry and its association with personality in a natural setting. Participants were required to engage in a randomly paired role-play task. Mimicry

was defined using a 10 s time interval. From the analyses of coded video recordings, it was identified that neuroticism, extraversion, and dominance enhanced mimicry of negative behaviours, while affiliation and agreeableness enhanced mimicry of positive behaviours. The researchers identified no effect of gender on facial or behavioural mimicry.

Discussion

The results of the current review are inconclusive. While 11 studies showed some difference between male and female mimicry behaviour, 19 studies reported no such differences. Thus, it appears that the question of whether or not there are male and female differences in mimicry behaviour remains unsettled. Nevertheless, it must be asked why some studies find an effect of participant sex or gender and not others?

Sex or Gender?

Interestingly, few studies reported how they measured participant sex or gender. It is not clear whether participants were categorised according to the researchers’ judgement, or whether sex or gender was self-reported. Further, most articles used both terms interchangeably, for example, reporting on opposite-sex pairs but conducting a gender analysis. It is only in reading the article entirely that it becomes clear that the majority of the studies were in fact discussing gender, and the potential impact of gender socialisation as opposed to biological sex. For this reason, when discussing the findings of these articles, the term gender will be used as opposed to sex.

Measuring Mimicry

The measurement of mimicry often involves paying attention to subtle micro-expressions or movements; add to that the ability to identify differences between males and females and it becomes clear that very precise measurements are needed (Chartrand & Bargh, 1999; Sonnby-Borgström, 2002). From this review, it can be identified that the main difference between studies that found gender differences and those that did not is whether or not they used observational coding. Of the 30 reviewed articles, 47% of those using facial EMG found some effect of gender, whereas only 29% of those using observational coding found an effect of gender. While observational methods are more appropriate for natural or semi-naturalistic settings, when aiming to investigate subtle differences between groups, laboratory settings and facial EMG are preferable.

Stimulus Exposure Length

However, within facial EMG studies there were also variations in the methodology of studies reporting an effect of gender and studies that did not. In relation to what each article defines as mimicry, time limits varied considerably and these time limits appear to be relevant for the identification of gender differences. For instance, Sonnby-Borgström (2002) first identified gender differences in facial mimicry at the automatic level between 17 ms and 30/40 ms; however,

in a later more thorough, gender-specific investigation, Sonnby-Borgström et al. (2008) revised this time frame having only demonstrated gender differences (in favour of females) at the supraliminal level (2,500 ms). A later study by Hermans et al. (2009) employed a mimicry time limit of 1,500 ms and also found significant differences in favour of females. However, when the time increases further to 3 s (Moody & McIntosh, 2011) or 8 s (Vrana & Gross, 2004) there no longer seem to be significant gender differences in facial mimicry.

Studies on facial emotion recognition have also shown interesting gender differences. For instance, Palermo and Coltheart (2004) showed that, between 500 ms and 2,500 ms, there are no gender differences in speed of emotion recognition; however, females perform better than males on recognition accuracy. From these findings, it can be proposed that between Sonnby-Borgström et al.'s. (2008) borderliminal and supraliminal time limits, females may appear to mimic more as their perception of emotion is more accurate than males at this time point. Studies using facial EMG data to assess facial mimicry do so by investigating the degree of overlap between the facial expression presented and the expected muscle activity for that particular expression. Thus, it may be argued that accuracy in facial recognition may account for male and female differences in facial mimicry, depending upon stimulus exposure lengths.

Social Context

Returning to the observational studies, given the importance of social context for gendered social behaviour, it stands to reason that the social context in which mimicry occurs should be important for the examination of male and female differences. Interestingly, van Straaten et al. (2008) found that for men, more so than women, level of mimicry was affected by the attractiveness of the interaction partner, in that, men were more likely to mimic their interaction partner if their partner was considered highly attractive. In addition, gender differences were also found to depend on social status, in that, women were more likely to mimic interaction partners of higher perceived social status than lower. These findings may reflect societal stereotypes of men and women such as the need for men to appear charming and lascivious, and women to be submissive (Prentice & Carranza, 2002).

Alternatively, evolutionary perspectives on mimicry provide some clarification as to why attractiveness and social standing may influence mimicry. It is suggested that mimicry played an important role in human evolution and may have had survival value by assisting human communication and reproduction. Mimicry increases affiliation, fostering positive social relationships with others (de Waal, 2008). According to evolutionary theory, stable social relationships with close individuals were important for the well-being and reproductive success of males, as well as for the protection of females and children (Kenrick, Sadalla, Groth, & Trost, 1990). Therefore, the increased tendency for males to mimic more attractive individuals may be a function of male evolutionary

behaviour involving the use of mimicry in potential reproductive relationships. Likewise, the tendency for women to mimic males with higher social status may be linked to the evolutionary benefit for women to connect with males equipped to provide for a family (Kenrick et al., 1990).

Cultural Differences

Returning to the findings of Safdar et al. (2009), it was expected that regardless of where the studies were conducted, there should be differences between males and females in relation to the display and mimicry of 'soft' and 'strong' emotions. Interestingly, of the studies that found gender differences, five studies reported that females were more likely than males to mimic joyful expressions, and males were more likely than females to mimic angry expressions (Hess & Bourgeois, 2010; Lundqvist & Dimberg, 1995; Rueff-Lopes et al., 2015; Sonnby-Borgström et al., 2008; Soussignan et al., 2013). While these results seem to support Safdar and colleague's (2009) hypotheses, all reviewed studies were conducted in developed countries, therefore, more cross-cultural data is needed in order to clarify the role of culture in gendered mimicry.

Stimulus Type

Given that previous studies have shown that the dynamism and perceived authenticity of the stimulus type can have an impact on mimicry behaviour, it was expected that this may have been a discriminating factor between studies that did and did not report gender differences (Krumhuber & Kappas, 2005). However, on the whole this does not appear to be the case, and more specifically, Rymarczyk et al. (2011) did not find any effect of gender when testing both static and dynamic stimuli. Nevertheless, Hess and Bourgeois (2010) identified that women tend to mimic smiles regardless of whether or not the smiles were genuine or forced, whereas men mimicked smiles to a lesser extent when the experimental condition involved higher levels of forced as opposed to genuine smiles. Unfortunately, no study directly tested the hypothesis that males and females may perceive the authenticity of stimuli differently and its relation to stimuli dynamism, thus, further investigation is warranted.

Conclusions

To conclude, few studies of nonconscious mimicry have shown to use mixed gender samples, of which even fewer have conducted gender analyses. Despite knowing a considerable amount regarding the biological sex differences and elements of gender socialisation that may have an impact on mimicry, few of these findings have been considered by the current mimicry literature. Furthermore, methodological disparities and a lack of precision in the definition of mimicry limit the amount of confidence that can be placed in the findings of the reviewed studies. In consideration of these points, the results of the current review suggest that gender differences may or may not be observed in human mimicry depending upon, among others, the type of mimicry measurement used, stimulus exposure length, and social context. Research on nonconscious mimicry has

developed significantly since Lipps proposition in 1907, yet, while much of the research has furthered our knowledge regarding the general social function of mimicry, the applicability of these research findings to both males and females is as yet unclear.

Although we cannot yet discern the role of sex in human mimicry, the current evidence base is lacking as a result of the failure to include sex or gender differences in study designs and analyses. The potential reporting bias created by either excluding a gender analysis or using female samples only maintains a situation where current research guidelines based on the study of one gender are generalized and applied to both. For instance, one example involves the finding that social context and exposure length differentially influence male and female mimicry; this finding requires a more gender specific study design in order to avoid simply measuring gender differences.

To conclude, future research investigating nonconscious mimicry should aim to recruit male and female participants, critically evaluate the appropriateness of observational and facial EMG measurements for their study design, use different stimulus presentation times, report on the social context of the study and study participants, and include cross-cultural comparisons.

Conflict of Interests Statement

I, Christine Marie Lehane, certify that I have no affiliation with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Competing Interests

The author declares that they have no competing interests.

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