universität wien

MASTERARBEIT | MASTER'S THESIS

Titel | Title

The Influence of Gender on Laughter and Affiliation

verfasst von | submitted by

Laila Geller-Hartung BSc

angestrebter akademischer Grad | in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien | Vienna, 2024

Studienkennzahl lt. Studienblatt | Degree programme code as it appears on the student record sheet:	UA 066 840
Studienrichtung lt. Studienblatt | Degree programme as it appears on the student record sheet:	Masterstudium Psychologie
Betreut von | Supervisor:	Univ.-Prof. Dipl.-Psych. Dr. Stefanie Höhl

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ABSTRACT

Laughter is a universal human nonverbal vocalisation that serves as an expression and communication of emotions. Because of its contagiousness and high occurrence in social settings, laughter is believed to foster cooperation and bonding. As societal expectations regarding the display of affiliative behaviours differ between sexes, we propose an influence of gender on the relationship between laughter and affiliation. In this study, we aimed to examine these influences in two aspects. Firstly, we explored how a potential association between laughter frequency and affiliation judgments by their interaction partner is influenced by gender of the laugher. Secondly, we investigated potential behavioural gender differences in laughter mimicry and examined its association with interaction partner's affiliation as well as feelings of closeness. The study utilised the free interaction phase of a laboratory study with 41 same-sex dyads of 18- to 25-year-old unacquainted participants. Questionnaires were administered to measure participants' liking of their interaction partner and feeling of closeness towards them. Additionally, laughing behaviour and laughter mimicry were recorded and manually coded. Results were analysed using regression and moderation analyses. No interaction effect of gender on the relationship between laughter frequency and affiliation judgments was found. Also, no relationship between laughter mimicry, partner's affiliation and feelings of closeness was found. However, differences between genders in laughing behaviour as well as affiliation judgments were present. Small sample size and several statistical limitations might have biased the outcome. To gain a better understanding of how gender influences the dynamics of laughter and its impact on social connections, further studies are necessary.

Keywords: *laughter, affiliation judgment, liking, bonding, stereotypes, gender differences*

Introduction

All of us humans start laughing in our first year of life (Gervais & Wilson, 2005) and it stays with us thenceforth. We laugh in conversations with friends, when playing games, when getting tickled and sometimes also while getting to know strangers. In literature, laughter is defined as a human nonverbal vocalisation that is universally understood as an expression and communication of positive emotions (Sauter et al., 2010). It manifests in rhythmic acoustic patterns (Vettin & Todt, 2004) through an altered way of breathing (Kohler, 2008).

Due to its contagiousness (Scott et al., 2022) and its main occurrence in social settings (Dunbar, 2012; Provine & Fischer, 1989), laughter is widely believed to serve social functions such as cooperation and bonding among individuals and within larger groups (Dunbar, 2012, 2022; Gervais & Wilson, 2005; Navarro et al., 2016). Research indicates, that often, laughter (Reed & Castro, 2022) and humour (Sacco et al., 2018) serve as a signal of group affiliation and belonging. Accordingly, laughing with another person has been shown to predict greater intimacy, positive emotions, and enjoyment in subsequent social interactions (Kashdan et al., 2014). Therefore, laughing in a conversation seems to have an impact on affiliation and bonding with strangers. The present study will explore this potential association between laughter and affiliation and will also investigate potential influences of gender.

Societal Influence on Laughter

Laughter appears to have evolutionary roots. Play vocalisations can be observed in various mammal species (Panksepp, 2000, 2005; Panksepp & Burgdorf, 2003, p. 200), and play vocalisations of great apes, in particular, bear resemblances to the mechanisms and properties of human laughter (Davila Ross et al., 2009; Davila-Ross et al., 2011; Ross et al., 2010; Winkler & Bryant, 2021).

Nonetheless, we humans have some distinct features that discriminate us from other animals. One of them is the ability to volitionally produce sounds, including the volitional production and alteration of nonverbal sounds such as laughter (Pisanski et al., 2016). We do not only laugh involuntarily while being tickled or finding something funny, but also in order to communicate and transmit additional information in social interactions. In literature, this voluntary laughter is also referred to as non-Duchenne laughter (Gervais & Wilson, 2005).

Furthermore, our ability of volitional sound production led us to language, a tool for the exchange of thoughts, feelings, and ideas (Pisanski et al., 2016). This headstone of social structure, meaning the formation and transmission of culture, politics, and historical tradition, has a great impact on human behaviour and experience via psychological development. Accordingly, it has been repeatedly shown that from the first year of life on, infants rely on caregivers as emotional referents in ambiguous situations (Ehli et al., 2020), also concerning their caregivers' laughter (Mireault et al., 2014). This so-called social referencing is most likely the foundation for social learning and social appraisal in adulthood (Walle et al., 2017). So, we as a highly social species learn what to laugh at and how to interpret others' laughter, at least partly influenced by societal structure and cultural values. Concordantly, cultural differences in judgments of the social meaning of emotional expressions such as smiling (Namba et al., 2020) – arguably directly related to laughter (Wood et al., 2022) – might imply cultural differences in function and meaning of laughter as well. Concluding, one could say that laughter is a lot more 'nuanced, complex and socially important' (Farley, 2022) than just an evolutionarily developed portrayal of fun and play.

Laughter Influences our Perception of Others

Laughter seems to be a context-dependent social tool. For instance, the purpose of laughter seems to differ across situations. In a qualitative study by Robinson & Smith-Lovin (2001) the function of laughter in new groups changed over time. First, laughter served as clarification of social hierarchies within the group. But later, it was rather used to dissipate task-related tension among group members. Another example for context-dependency is the lack of interpretability of conversational laughter by strangers. Apart from intensity, laughter itself does not appear to provide information about the reason of laughing (Curran et al., 2018). Suitably, Rychlowska et al. (2022) also found that people need the context of a conversation to distinguish laughter of amusement, laughter of embarrassment and laughter of schadenfreude from one another.

However, despite its context-dependency, ambiguity and underdetermination, a person's laughing behaviour seems to be used as a cue for personality judgments. According to a qualitative study with clients in a therapeutic setting (Gupta et al., 2018), laughter can indicate both socially desirable psychological states such as cheerfulness or politeness – associated with agreeableness and extraversion – and less positively connotated states like contemptuousness or nervousness. However, Smartt et al. (2022) found that laughter is actually used to estimate the counterpart only in a socially desired way: People were judged

as more extraverted, agreeable, conscientious and open to new experiences when they were laughing than when they were not. But, using laughter as a cue sharpened accuracy only in extraversion judgment. Consistently, in a study by Reysen (2006) individuals were perceived as more likeable when they were laughing than when they were not, regardless of whether the laughing was genuine or not.

Putting it together, laughter seems to be a culturally influenced and context-dependent social tool, that is also used to perceive and integrate knowledge of the other person. Yet, these judgments may not be completely accurate.

How about Gender?

Gender stereotypes and corresponding behavioural and trait expectations (Prentice & Carranza, 2002) are documented to influence our judgment of other people's behaviour in different contexts (Biernat, 2005, Chapter 5; Heilman, 2012; Malcolm et al., 2014; Romeo & Horn, 2017). Especially not complying with expectations and prescriptive stereotypes seems to attract attention, leading to rather negative judgments (Ellemers, 2018; Wang et al., 2023). This reliance on gender labels as judgment cues is observed from an early age on and seems to remain stable developmentally (Biernat, 1991; Wang et al., 2023).

Gender in Affiliation Judgments of Laughter

Laughter, being context-dependent and ambiguous, does not appear to represent an exception regarding gender labels as judgment cues: One study did observe respective gender effects on affiliation ratings of laughter. Bachorowski and Owren (2001) played 70 audiotapes of conversational voiced and unvoiced laughter to female and male students and asked to rate them regarding their friendliness, sexiness, own affective response, whether the audio should be added to a laugh-track and their interest of meeting the person behind the audio. Female laughter received more extreme ratings in friendliness, own affective response, and interest in meeting by both female and male listeners. Here, female unvoiced laughter was rated lower than male unvoiced laughter, and female voiced laughter was rated higher than male voiced laughter. Especially ratings of unvoiced female laughter were consistently more negative than ratings of unvoiced male laughter.

This study suggests that laughter as a judgment cue for affiliation is used differently depending on the laughing person's gender. Also, one might assume that for women, laughing behaviour is a more important cue for affiliation judgments. This interpretation could also explain a study on smiling, where facial expressions in alignment with gender stereotypes seemingly played a larger role in judgments of women than men (Hack, 2014).

Women who smiled were evaluated more favourably on traits related to warmth (associated with female gender) than men, while men's facial expressions did not influence ratings of competence (associated with male gender, see e.g. Ellemers, 2018). Additionally, people ascribing more strongly to traditional female stereotypes evaluated female smiling faces more favourably, implying that indeed stereotypical beliefs and gendered expectations play a role in affiliation judgments.

These findings are consistent with research suggesting that women are expected to display affiliative behaviours more than men, as well as prescriptive stereotypes describing warmth as a rather female trait (e.g. Fiske et al., 1999; Hess et al., 2005). Both smiling and laughing are behaviours that can reflect affiliative traits and warmth (Bayes, 1972; Reed & Castro, 2022).

Research Gap

Bachorowski and Owren (2001) found gender effects on affiliation ratings of laughter. However, they presented participants audio recordings of laughter to evaluate, a setting that excludes interaction and bonding effects between two people. Also, participants evaluated laughter itself. Therefore, it is still unknown how gender influences the relation between laughter and affiliation in natural interactions, and in the context of relating to new people. Thus, our research question is: **Is there a relation between laughter and affiliation in interactions with strangers, and is it influenced by gender?** The first hypothesis would be **H1: In a free interaction between two unknown people of the same sex, individuals that laugh more get higher likeability judgments by their counterpart.**

The objective is to explore broader effects of gender. As mentioned earlier, there appears to be a tendency to judge women's laughter more extremely in terms of its quality. Another potential concept is that the *quantity* of women's laughter has a more significant impact on affiliation judgments compared to the quantity of men's laughter. The underlying notion is that due to prescriptive stereotypes expecting women to display warmth and affiliative behaviour, not laughing enough might be perceived as non-compliant with the norm, leading to more negative affiliation judgments. Therefore, the second hypothesis includes an interaction effect: **H2: The relation between laughter frequency and likeability judgments is stronger for women.**

Gender Differences in Laughing Behaviour

The proposition above posits that gender may influence how women and men are perceived in the context of laughter. But when thinking about gender, yet another question

comes up: do women and men also exhibit differences in their laughing behaviour? Gender stereotypes and expectations do not only influence people's perception of others. They are imposed onto us from very early on (e.g. Gonzalez et al., 2021) throughout our whole life, and conforming to a given social role often serves the advantage of social affiliation and acceptance (Ellemers, 2018). Thus, people adapt their behaviour to normative gender expectations (e.g. Granié, 2009) and even integrate and internalise certain stereotypical traits into their perception of self (e.g. Hentschel et al., 2019; Nadal et al., 2021) and performance (e.g. Bonnot & Croizet, 2007). So, if gender stereotypes affect judgments on laughter, one might also find gender differences in laughing behaviour.

Research on Behavioural Gender Differences

As often the case in research on behavioural gender differences, it is not perfectly clear whether there are differences in laughing frequency. Provine (1993) found that women tend to laugh more frequently than men in social interactions. Additionally, one study observed that girls reciprocate boys' laughter more often than vice versa (Chapman & Foot, 1976). However, Martin and Kuiper (1999) examined laughing behaviour across various age groups and did not find consistent gender effects in laughing frequency. Similarly, a newer study by Haviva and Starzyk (2022) involving older individuals did also not reveal generalised gender differences.

While there might be no general gender differences in frequency of laughter, studies do suggest that the qualities of laughter differ. Laughter is not always an affiliative signal (Mauersberger et al., 2022; Reed & Castro, 2022), and here the gender difference might take place. Robinson and Smith-Lovin (2001) found that men more often engage in differentiating humour, emphasising individuality or superiority, while women's humour tends to be more cohesion-building, fostering affiliation. Similarly, Gupta et al. (2018) observed that female patients exhibit less contemptuous laughter compared to male patients. These studies imply that women's laughter more often purposes in-group signalling, cohesion building or bonding than men's laughter. Therefore, looking into more specific qualities of laughter could help us understand what it is exactly that makes a difference.

Laughter Mimicry as the sought-after Variable for Gender Difference

Mimicry are automatic and often unconscious imitations of other people's behaviour. This interpersonal contagion includes gestures, mannerisms, postures, facial expressions, emotional experience and reactions, and even verbal output (Chartrand & Lakin, 2013). As laughter can provoke direct and immediate imitation due to its contagiousness, it is classified

as a form of mimicry. This so-called laughter mimicry is defined as the 'production of laughter within 1 second from the end of a previous laughter produced by an interactant' (Mazzocconi et al., 2023, p. 2).

So, why engage in mimicry? Behavioural mimicry in general has been shown to create liking (Chartrand & Bargh, 1999), affiliation (Lakin & Chartrand, 2003), and feelings of bonding (Stel & Vonk, 2010) between interactants. Additionally, it seems to induce perceptions of trustworthiness and compliance (Van Baaren et al., 2009). Accordingly, a study by Lakin & Chartrand (2003) suggests that people nonconsciously use behavioural mimicry when attempting to create rapport. Therefore, the authors refer to it as the 'social glue' that brings people together and bonds them.

Likewise, the contagious nature of laughter is assumed to be the reason for laughter leading to alignment, hence affiliation and feelings of closeness (Scott et al., 2022). Concordantly, mimicry laughter is also believed to play an important role for showing agreement and affiliation as well as for establishing relationships (Kurtz & Algoe, 2017).

Research Gap

Interesting about all this is, that in emotional contagion and imitation, gender differences have been observed. Both in self-report and interaction observation, women seem to experience more emotional contagion (Doherty et al., 1995; Sonnby-Borgström et al., 2008). Also, women seem to employ more mimicry of joyful facial expressions than men (Dimberg & Lundquist, 1990; Hess & Bourgeois, 2010; Rueff-Lopes et al., 2015; Sonnby-Borgström et al., 2008; Soussignan et al., 2013).

Concluding, researching gender differences in *laughter mimicry* might be the key to ambiguous research results of behavioural gender differences in frequency. Therefore, our second research question is: **Does laughter mimicry influence affiliation and do women mimic laughter more than men do?** One corresponding hypothesis, comparing men to women, will be **H3: Women mimic laughter of an unknown same-sex counterpart in a free interaction more often than men do.** The fourth hypothesis then will take liking and feelings of closeness into account. **H4: The amount of mimicked laughter in a free interaction correlates positively with liking and feelings of closeness of an unknown same-sex counterpart.**

Methods

This study was part of an ongoing research project called 'Laughing Together' (LT), taking place at the institute of Developmental Psychology at University of Vienna, Austria. The data collection started in June 2022. The aim of LT is to investigate the influence of laughter on interpersonal synchrony and cooperation in a laboratory setting. LT was authorised by the ethics committee of the University of Vienna. Participants filled out an informed consent and were briefed about their right to cancel participation at any time. Upon completion, all participants were debriefed about the actual aim of the study.

Procedure of LT

For the approximately 120 minutes long lab experiment, 18- to 25-year-old participants were assembled as strangers in same-sex dyads with a maximum age difference of 4 years. Additionally, blind assignment to one of the following four conditions took place: Interaction + Laughter *(IL)*, No Interaction + Laughter *(NIL)*, Interaction + No Laughter *(IC)*, and No Interaction + No Laughter *(NIC).* Before start, functional near-infrared spectroscopy (fNIRS) and other physiological measurements were attached and adjusted, and participants separately filled out several questionnaires, including questions about liking the other participant. In the manipulation phase, participants first played cloze texts and watched animal videos. Here, either laughing (Laughter conditions) or solely positive affect (No Laughter conditions) were induced by piloted funny versus neutral cloze texts and funny versus cute animal videos. Also, either participants played alone, and watched and rated the videos alone (No Interaction), or they played together and watched and rated the videos together (Interaction). The second phase consisted of 10 minutes of free interaction without experimenters in the room. Here, participants were not informed of this phase to be part of the study: Experimenters left the room stating that they were looking for their colleagues in order to proceed with the next task. In the last phase, participants again filled out questionnaires, amongst others about liking and feelings of closeness towards the other person, before playing a cooperation game together. During the whole experiment, physiological measurements stayed on, and participants remained seated. Heartbeat, neural synchrony, behavioural synchrony, and laughing were measured throughout the study.

Sample

Participants were recruited distributing flyers at different university campuses and other localities for young adults. Recruiting also took place online with the University recruitment system SONA, and the Vienna Cognitive Science Hub Study Participant

Platform. Also, flyers were sent into several Viennese social media study- and chat groups. Before getting an appointment to the lab, the prospects were asked about psychological or neurological diagnoses as well as sociodemographic variables. Also, they filled out a pre-screening for depression, social anxiety, and autism spectrum. Only 18- to 25-year-old participants without diagnoses or conspicuousness in the psychiatric pre-screenings were then invited to take part in the study. As an incentive, participants were promised either a financial compensation of 15 Euros or credit points for their study. Therefore, this sample can be considered a convenience sampling with mostly students, especially of psychology, as participants.

Measurements

Laughing Behaviour

For this study, we used the free interaction phase of the interaction conditions IL and IC to measure laughing behaviour. 3 cameras with 25 frames per second and three microphones recorded the interaction. Video- and audio recordings were coded by two master students using the linguistic coding program ELAN (Brugman & Russel, 2009). The rules of coding were determined beforehand, and geared to a study of Mazzocconi et al. (2022): A laughter segment starts when a facial expression with an auditive expression or body movement related to laughter was observed and stops when a breath intake was perceived audibly or visually through body movement. If no breath intake could be observed, the segment stops when movements and auditive expressions were not perceived anymore. If only facial expression was observed without any additional movement or auditive expression like mentioned before, it was considered smiling and was not coded (Mazzocconi et al., 2022). In addition to these rules, laughter was not coded if the occurrence of laughter was unclear and marked as such if the corresponding person was not detectable. If laughter was not perceived anymore but then continued within 300 milliseconds or less, it was considered one coherent segment of laughter. Also, every laughter was coded to last a minimum of 300 milliseconds.

Before start of the coding, interrater reliability had to be assured. First, coding was practiced, discussed, and improved with several pilot videos. This process was continued until interrater reliability was considered to be sufficiently high. A Degree of Organization value (DO) was calculated within ELAN with the Staccato software, which is based on the Thomann algorithm (Lücking et al., 2012). This value describes the agreement on laughter identification with its exact starting and ending borders. For interrater reliability, 6 different

videos from the pilot study were used, and their DOs were averaged to gain an overall DO. The calculation used 1000 Monte Carlo Simulations and 10 nomination slots. Alpha was set at .05. The overall degree of organisation was considered to be enough ($DO_{overall}$ = .85) and thus coding was started.

Laughter Mimicry

To measure laughter mimicry, we used a script for R (R Core Team, 2023) developed by Mazzocconi et al. (2023), in which mimicry is defined as laughter that starts within 1 second before the end of an interlocutor's laugh, without the interlocutor starting again before the segment stops. As it is very difficult to distinguish *mimicking* from *being mimicked* in laughter that started nearly simultaneously, and as it is unlikely for the counterpart to detect and reproduce laughter in very few milliseconds, we changed the script regarding starting points of under 100ms. Here, both participants would be coded to have mimicked one another. With this adjustment, we would also resolve the problem of the script ascribing a mimicry only to person A, when both annotations start at the exact time point. Also, any mistakes made because of manual micro-coding would be controlled for.

Questionnaires

To measure liking of the interlocutor, three questions by Lakin and Chartrand (2003) translated into German ('Wie wohl fühlst du dich mit der anderen teilnehmenden Person?', 'Wie sympathisch ist die andere teilnehmende Person?', 'Würdest du gerne mehr Zeit mit der anderen teilnehmenden Person verbringen?') were given before the experiment starts and after the free interaction phase. The items were answered on a 9-point scale from 0 to 8, with higher numbers indicating a more favourable answer. For this study, only questionnaires filled out after the free interaction phase were used. The decision of not taking the first filled out liking questionnaire before start is because of its theoretical implication. The first questionnaire is filled out after having put on the functional near-infrared spectroscopy caps without a lot of interaction with their dyad partner. Therefore, its meaning is rather a first impression of the other person than likeability. Considering their first impression in the analyses, the second impression would be rather a correction of intuition or initial attraction. Therefore, we used the post-score as measurement only.

For feeling of closeness, the *Inclusion of Other in the Self Scale* (IOS; Aron et al., 1992) with instructions translated into German was given after the free interaction. This single item is a depiction of two circles, and respondents have to mark how much overlapping of both circles describes their relationship with their interaction partner best.

The total areas of each circles stay the same size, and the circles overlap linearly in 7 increments, making it interval scaled.

Data Collection and Analysis

For this study, participants of the conditions IL and IC were used. Because of issues with the videorecording, one male dyad in IL got excluded, making a total of 41 dyads and 82 participants suited for coding and statistical analysis. In IC, 20 dyads, of which 10 were female, and in IL, 21 dyads, of which 13 were female, participated. In total, 56 % of the dyads were female. The age range of the whole sample was between 18 and 25 years (M_{age} = 21.45, *SD* = 1.964).

The data is structured in dyadic relationships. Therefore, people within a dyad cannot be assumed to be independent of each other. This problem was addressed by splitting each dyad of the dataset and randomly assigning dyad members to one of two subsamples. Thus, the two subsamples each consisted of one person of every dyad. This way, all analyses were computed twice, first with *subsample 1* (SS1, *n* = 41) and then 'replicating' with *subsample 2* (SS2, *n* = 41).

First Research Question. For the first hypothesis H1 (*In a free interaction between two unknown people of the same sex, individuals that laugh more get higher likeability judgments by their counterpart)*, a simple linear regression was computed for both subsamples. Predictor was number of laughs and outcome would be partner's sum of the points on the liking questions. For a small effect of f^2 = .02, an error probability of α = .05, and power of 80%, a simple regression analysis (one-tailed) would need 395 participants.

For H2 *(The relation between laughter frequency and likeability judgments is stronger for women),* a moderation analysis was calculated with amount of laughter as predictor, gender of participant (male or female) as moderator, and liking by interaction partner as outcome. Again, amount of laughter was defined as the number of laughs. For a small effect of f^2 = .02, an error probability of α = .05, and power of 80%, a moderating effect (one-tailed) would need 395 participants.

Second Research Question. As each mimicry is dependent on a laugh of the partner, one might assume a ratio (mimicries / partner's laughs) to be a solution to work with. Mazzocconi et al. also used this ratio, which would be the 'probability of laughter mimicry occurring in one participant over the total number of laughs produced by their partner' (2023, p. 255), calling it *Transitional Probability.* However, when using ratios, the base rate is not transparent, quickly leading to misinterpretations (Bar-Hillel, 1980). Especially using ratios in regressions as predictors, although still used and accepted in social sciences

(Vilsmeier et al., 2023), can lead to highly biased outcomes and interpretations (Wiseman, 2009).

Therefore, in H3 (*Women mimic laughter of an unknown same-sex counterpart in a free interaction more often than men do)*, to predict mimicry, we planned a regression with total number of laughs produced by their partner as predictor. To explore our hypothesis whether sex can explain any additional variance of this relationship, we included sex as an additional predictor. For an effect size of $f^2 = .435$, error probability of $\alpha = .05$, and power of 80%, a multiple regression would need 26 participants. The chosen effect size is based on Rueff-Lopez et al. (2015), who found a significant effect for gender differences in positive vocal mimicry ($U = 44.073$, $n_1 = 908$, $n_2 = 117$).

In H4 *(The amount of mimicked laughter in a free interaction correlates positively with liking and feelings of closeness of an unknown same-sex counterpart)*, we included the ratio by conducting a moderation analysis, as proposed by Wiseman (2009). Predictors were planned to be the inverse of laughs of the other, number of mimicries, and an interaction of those two, which mathematically equals the probability ratio. Outcomes were on one hand the liking questions (Lakin & Chartrand, 2003) for liking, and on the other hand the IOS scale (Aron et al., 1992), measuring feeling of closeness. The questionnaires were filled out after the free interaction. For an effect size of $f^2 = .177$, error probability of $\alpha = .05$, and power of 80%, a moderation analysis would need 66 participants. The chosen effect size is based on Stel & Vonk (2010), who found a significant effect of behavioural mimicry on feelings of closeness ($\eta^2 = .15$) in a repeated measures ANOVA.

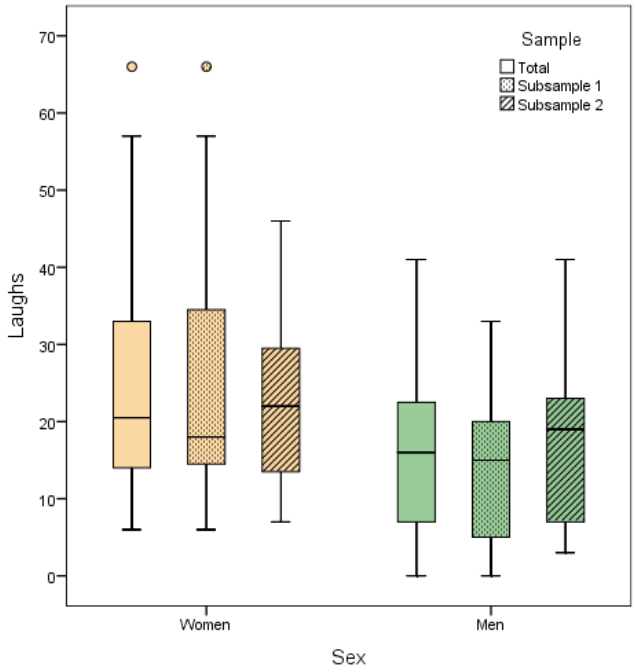
Calculations of power were conducted with the program G*Power 3.1 (Faul et al., 2007). Transformations of effect sizes were calculated as described by Lenhard and Lenhard (2017).

Results

Descriptive Information

Before data analysis, exploratory examination was conducted. The following figures display all variable distributions, classified by gender and subsamples. Laughs distribution is portrayed in Figure 1 and laughter mimicry distribution in Figure 2. In both variables, women seem to achieve higher means and medians (see also: Table C1 & Table C2). Figure 3 shows distribution of sum of liking questionnaire points given by partner. Figure 4 shows distribution of partner's answer on IOS scale. Except for IOS scale (Figure 4), all distributions of the whole sample follow the hypothesised direction of women achieving higher medians and means than men (see also: Table C1, Table C2, Table C3, Table C4).

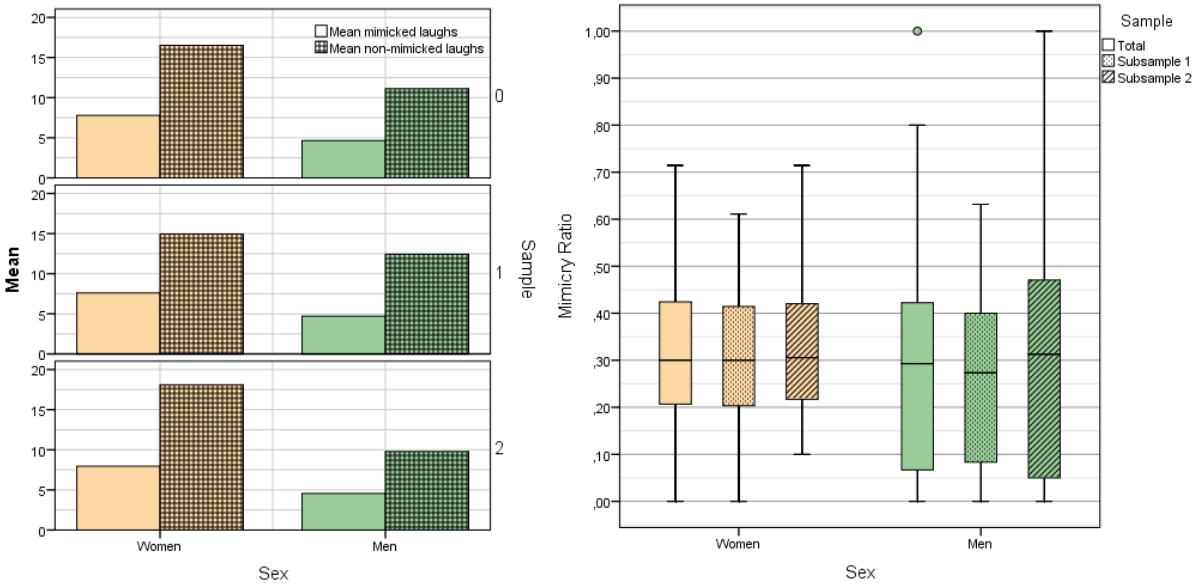
Figure 1



Note. 'Sample = Total' displays distribution of all participants of respective sex. 'Laughs' is quantity of laughs conducted in free interaction phase. Whiskers range from minimum to maximum values that are not considered outliers. Outliers are considered values over 1.5 x the interquartile range.

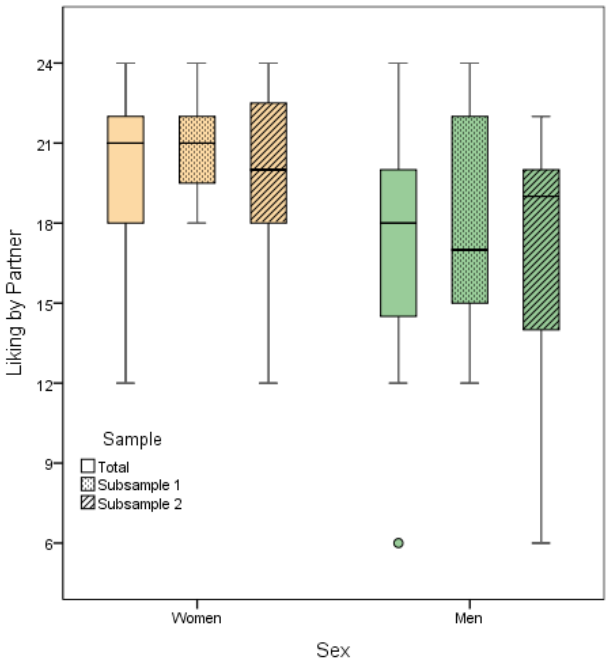
Figure 2

A) **B)**



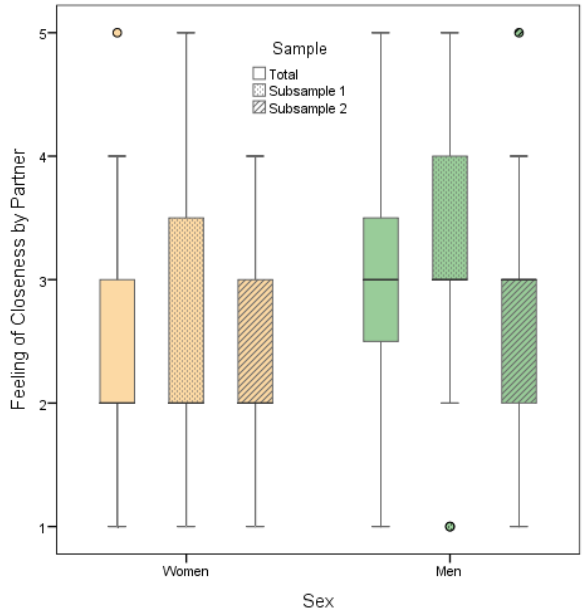
Note. Figure A) shows mean mimicking compared to mean non-mimicking. First row (Sample = 0) displays means of all participants of respective sex, while second (Sample = 1) displays means of subsample 1 and third row (Sample = 2) displays means of subsample 2. Figure B) displays boxplots of mimicry ratio, which was calculated by dividing count of mimicries by laughs executed by their partner.

Figure 3



Note. 'Sample = Total' displays distribution of all participants of respective sex. 'Liking by Partner' is sum of points of three liking questionnaire answers given by the partner, in which higher points means a more positive judgment. Whiskers range from minimum to maximum values that are not considered outliers. Outliers are considered values over 1.5 x the interquartile range.

Figure 4



Note. Sample = 'Total' displays distribution of all participants of respective sex. Feeling of closeness by partner were answers on the IOS scale, a single item with a minimum of 1 and a maximum of 7, filled out by respective partners. Higher points indicate a more positive judgment regarding perceived closeness. Whiskers range from minimum to maximum values that are not considered outliers. Outliers are considered values over 1.5 x the interquartile range.

A Priori Analysis

One model assumption for linear regression is the independence of observations. Dyads were split to address the problem of dyadic dependency. Still, to not lose power any further, the problem of belonging to one of the two conditions IL and IC was not addressed in analyses. Hence, conditional grouping could have a bias on standard errors, resulting in type-1 errors. To look further into a potential influence of the conditional grouping, IC and IL was compared regarding all used variables. As residuals distribution did not show normality in any variable except for laughs in subsample 2 (Table 1), non-parametric Mann-Whitney U-tests were used to get robust results.

Table 1

Shapiro-Wilk Tests for all used dependent and independent variables.

	W	***df***	***p***
Laughs SS1	.905	40	.003
Laughs SS2	.952	40	.086
Mimicry SS1	.844	40	.000
Mimicry SS2	.927	40	.012
Partner's Liking SS1	.944	40	.048
Partner's Liking SS2	.938	40	.030
Partner's Closeness SS1	.922	40	.009
Partner's Closeness SS2	.916	40	.006

Table 2 lists all computation results. Only IOS scale of subsample 2 pointed towards a significant difference. However, Bonferroni-corrected alpha level ($\alpha_{altered} = .05/8 = .006$) was not exceeded in any variable. However, dependence of observation still must be treated as a limitation of potential significant results, as also nonsignificant differences might lead to biased estimates.

Table 2

Mann-Whitney U-tests of all variables, comparing conditions IC with IL.

Variable	Mean Rank IC (*n* = 20)	Mean Rank IL (*n* = 21)	*U*	*Z*	Asymp. *p* (2-tailed)
Laughs SS1	21.18	20.83	206.5	-.091	.927
Laughs SS2	24.10	18.05	148.0	-1.619	.105
Mimicry SS1	20.45	21.52	199.0	-.288	.773
Mimicry SS2	23.23	18.88	165.5	-1.166	.244
Partner's Liking SS1	23.10	19.00	168.0	-1.103	.270
Partner's Liking SS2	22.13	19.93	187.5	-.591	.555
Partner's Closeness SS1	25.95	16.29	111.0	-2.675	.007
Partner's Closeness SS2	20.16 (*n* = 19)	20.81	193.0	-.184	.854

Hypothesis 1

In order to use a linear regression model for H1 (*In a free interaction between two unknown people of the same sex, individuals that laugh more get higher likeability judgments by their counterpart)*, several assumptions need to be met. Predictor and outcome are interval scaled. Independence of observations was addressed by randomised dyad splitting, resulting in two subsamples.

Subsample 1. Additionally, residuals need to be distributed normally. Distribution was a bit left skewed without outliers. Normality of residuals was tested using Shapiro-Wilk (W = .981, p = .732). Here, insignificance means that the null hypothesis of normality is not rejected. Homoscedasticity was checked by plotting standardised predicted values with standardised residuals. As a random distribution of the data points was not clear, heteroscedasticity or nonlinearity cannot be ruled out with certainty, which led us to conduct a bootstrapping of 1000 samples.

The overall regression was statistically significant (R^2 = .156, F *(1, 39)* = 7.231, p = .01). Results of coefficients are shown in Table 3. Count of laughs significantly predicted partner's affiliation judgments. Bootstrapping confidence intervals did not include 0, indicating a good fit for the data. Thus, the null hypothesis could be rejected.

Subsample 2. Normality of residuals can be assumed (Shapiro Wilk, W = 0.961, p = 0.172). The plot of predictor and outcome variable shows a similar distribution to that of subsample 1 (Figure 5) with a slightly higher indication of linearity. Because of a slight cone

shape in standardised residuals plotted with standardised predicted values, heteroscedasticity cannot be ruled out. Therefore, bootstrapping of 1000 samples was conducted.

The overall regression was statistically significant (R^2 = .133, F (1, 39) = 5.970, p = .019). As shown in Table 3, laughs significantly predicted partner's affiliation judgments. Bootstrapped 95% confidence intervals did not include 0, indicating that the model provides a good fit for the data. Thus, a rejection of the null hypothesis could be replicated in SS2.

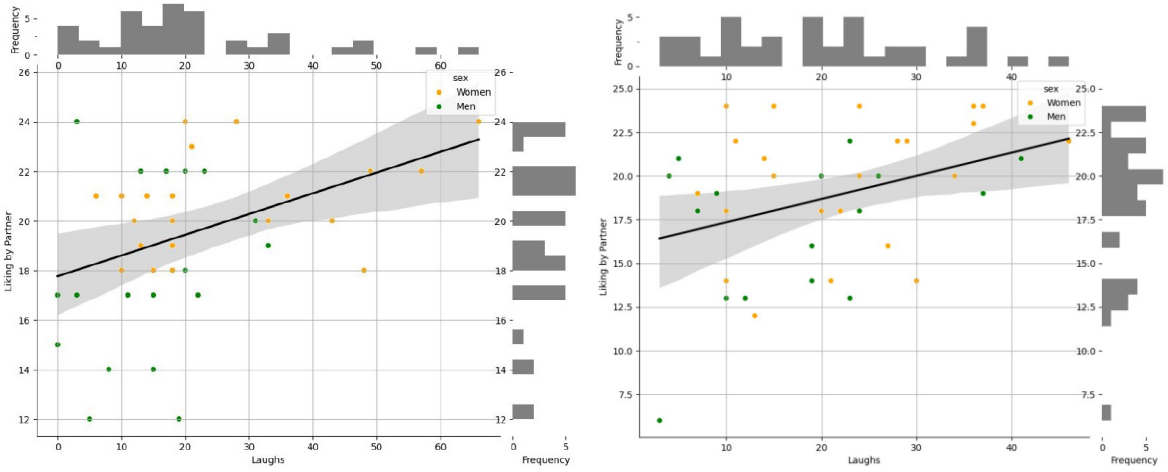
Table 3

Linear Regression of Both Subsamples. Bootstrap for Coefficients

					95% Confidence Interval	
		B	***SE***	***p* (2-tailed)**	**Lower**	**Upper**
SS1	Constant	17.764	.828	.001	16.099	19.438
	Laughs	.084	.026	.004	.036	.138
SS2	Constant	16.021	1.466	.001	12.960	18.777
	Laughs	.133	.055	.023	.023	.247

Note. Dependent Variable: Liking by their partner. Bootstrap results are based on 1000 bootstrap samples.

Figure 5



Note. Regression analyses of subsample 1 (left) and subsample 2 (right).

Hypothesis 2

For the second Hypothesis *(The relation between laughter frequency and likeability judgments is stronger for women)*, a moderation analysis was planned. Again, predictor was laughs and outcome was sum of liking points. Additionally, sex and the product term of sex

with laughs were included as predictors. Thus, all predictors were interval scaled, respectively dichotomous (sex), and outcome was interval scaled.

Subsample 1. Standardised residuals showed a right skewed distribution (min = -2.26, max = 2.61). Normality of residuals was given according to Shapiro-Wilk test (W = .981, p = .699). Also, no pattern was detected in standardised residuals plotted with standardised predicted values, indicating homoscedasticity as well as linearity. To avoid multicollinearity, all interval scaled predictors were mean centred. Additionally, computed collinearity statistics in predictors did not show any signs of collinearity (Laughs, *Tolerance* = .661, *VIF* = 1.513; Sex, *Tolerance* = .765, *VIF* = 1.307; Interaction, *Tolerance* = .619, *VIF* = 1.615), as tolerance values were over 0.1 and Variance Inflation Factors were under 10 (Field, 2018). To account for small sample size, a bootstrapping of 1000 samples was conducted.

The overall regression was statistically significant (R^2 = .287, F *(3, 37)* = 4.968, p = .005). Bootstrapped results of coefficients are listed in Table 4. Surprisingly, in this model, laughs did not predict partner's liking anymore. However, bootstrapped p-value was still under 10%. Only sex could significantly predict partner's liking. Here, 0 was not included, indicating a robust result. As the interaction term resulted to not be significant, the null hypothesis was not rejected.

Subsample 2. The same analysis was computed for subsample 2. No meaningful outliers were detected, and normality of residuals were given according to Shapiro-Wilk test (W = .951, p = .075). No pattern was detected in standardised residuals plotted with standardised predicted values, indicating homoscedasticity as well as linearity. To avoid multicollinearity, all interval scaled predictors were mean centred. Additionally, computed collinearity statistics in predictors did not show any signs of collinearity (Laughs, *Tolerance* = .52, *VIF* = 1.92; Sex, *Tolerance* = .94, *VIF* = 1.07; Interaction, *Tolerance* = .53, *VIF* = 1.89), as tolerance values were over .1 and Variance Inflation Factors were under 10 (Field, 2018).

The overall regression was concisely not statistically significant (R^2 = .183, F *(3, 37)* = 2.763, p = .056), meaning that the model does not provide a very good fit for the data. No predictors had significant explanatory power (see Table 4). Bootstrapped confidence intervals of all predictors included 0, thus the results are not robust. However, in sex only a small amount of the interval is in the positive range, indicating a trend in the same direction as in SS1.

Table 4

Moderation Analysis of Both Subsamples. Bootstrap for Coefficients.

					95% CI	
		B	***SE***	***p* (2-tailed)**	**Lower**	**Upper**
SS1	Constant	20.621	.416	.001	19.776	21.393
	Laughs	.040	.024	.084	-.012	.079
	Interaction	.057	.083	.467	-.118	.211
	Sex	-2.151	.989	.043	-4.194	-.258
SS2	Constant	19.539	.817	.001	17.942	21.098
	Laughs	.103	.068	.123	-.038	.237
	Interaction	.021	.122	.834	-.222	.269
	Sex	-1.829	1.152	.137	-4.047	.492

Note. Dependent variable: Mimicry. Sex is dummy coded with 0 as female and 1 as male. Bootstrap results are based on 1000 bootstrap samples.

Hypothesis 3

For H3 (*Women mimic laughter of an unknown same-sex counterpart in a free interaction more often than men do)*, a multiple regression analysis was conducted with predictors sex and laughs of their partner, and the outcome mimicry. For a multiple regression, several assumptions need to be checked for the analysis. Predictors are dichotomous (sex), and interval scaled (partner's laughs). The outcome mimicry is interval scaled as well.

Subsample 1. Although standardised residuals exceeded the maximum of 2.5 and were right skewed (*min* = -1.59, *max* = 2.54), Shapiro Wilk indicated normality of residuals (W = .959, p = .146). Partial regression plots of both predictors indicated linearity of residuals. A scatterplot of standardised residuals and standardised predicted values showed no specific pattern, indicating homoscedasticity. Computed collinearity statistics in predictors did not show any signs of collinearity (Sex, *Tolerance* = .94, *VIF* = 1.06; Partner's laughs, *Tolerance* = .94, *VIF* = 1.06). To account for the small sample size, bootstrapping of 1000 samples was conducted.

The overall regression was statistically significant (R^2 = .582, F *(2, 38)* = 26,470, p < .001) indicating that the model was a good fit for the data. Partner's laughs significantly predicted mimicry (Table 5) and its bootstrapping confidence interval did not include 0, implying a robust result. However, although pointing towards the assumed direction, sex did

not explain any further variance significantly. Its bootstrapped confidence interval included 0, implying a lack of robustness. Thus, the null hypothesis could not be rejected.

Subsample 2. Standardised residuals showed right skewness as well (*min* = -1.76, *max* = 3.123). Shapiro Wilk did not show any signs of nonnormality (W = .956, p = .115). Partial regression plots of both predictors indicated linearity of residuals, and the scatterplot of standardised residuals and standardised predicted values indicated homoscedasticity. Computed collinearity statistics in predictors did not show any signs of collinearity (Sex, *Tolerance* = .846, *VIF* = 1.182; Partner's laughs, *Tolerance* = .846, *VIF* = 1.182). To account for the small sample size and any overlooked assumption violations, bootstrapping of 1000 samples was conducted.

The overall regression was statistically significant (R^2 = .581, F *(2, 38)* = 26,324, p < .001), implying the model to be a good fit for the data. As well as in the first subsample, partner's laughs significantly predicted mimicry (see Table 5), with its bootstrapping confidence interval not including 0, implying robustness. Again, sex did not explain any further variance significantly, with bootstrapped confidence intervals exceeding 0**.** Thus, the null hypothesis could not be rejected.

Table 5

Multiple Regression of Both Subsamples. Bootstrap for Coefficients.

					95% CI	
		B	***SE***	***p* (2-tailed)**	**Lower**	**Upper**
SS1	Constant	-1.430	1.208	.247	-4.012	.748
	Sex	-.724	1.143	.561	-2.832	1.657
	Partner's Laughs	.401	.070	.001	.263	.537
SS2	Constant	1.293	1.235	.307	-1.302	3.589
	Sex	-.405	1.335	.775	-3.014	2.147
	Partner's Laughs	.256	.049	.001	.182	.365

Note. Dependent variable: Mimicry. Sex is dummy coded with 0 as female and 1 as male. Bootstrap results are based on 1000 bootstrap samples.

Hypothesis 4

For H4 (*The amount of mimicked laughter in a free interaction correlates positively with liking and feelings of closeness of an unknown same-sex counterpart*), a moderation analysis was planned with predictors mimicry and inverse of partner's laughs, as well as an

interaction term of both predictors, which is the ratio of mimicries per times of partner's laughs. Outcome was either sum of liking questions or IOS scale. For moderation analysis, several assumptions need to be checked. Predictors as well as outcomes are interval scaled.

Outcome Liking, Subsample 1. Standardised residuals are slightly left skewed (*min* = -2.30, *max* = 2.00). Shapiro Wilk test was insignificant (W = .976, p = .531), indicating normality of residuals. Scatterplot of standardised residuals and standardised predicted values showed no specific pattern, suggesting homoscedasticity and linearity. Computed collinearity statistics in predictors did not show any signs of collinearity (Mimicry, *Tolerance* = .366, *VIF* = 2.731; inversed partner's laughs, *Tolerance* = .711, *VIF* = 1.406; interaction, *Tolerance* = .464, *VIF* = 2.155). To account for the small sample size, bootstrapping of 1000 samples was conducted.

The overall regression model showed no significance (R^2 = .131, F *(3, 37)* = 1.859, p = .154), implying the model to be a bad fit for the data. Thus, the null hypothesis could not be rejected.

Outcome Liking, Subsample 2. Standardised residuals are left skewed (*min* = -2.51, *max* = 1.69). However, Shapiro Wilk test is insignificant (W = .968, p = .290), indicating normality of residuals. Scatterplot of standardised residuals and standardised predicted values showed no specific pattern, suggesting homoscedasticity and linearity. Computed collinearity statistics in predictors did not show any signs of collinearity (Mimicry, *Tolerance* = .508, *VIF* = 1.969; inversed partner's laughs, *Tolerance* = .519, *VIF* = 1.925; interaction, *Tolerance* = .512, *VIF* = 1.953). To account for the small sample size, bootstrapping of 1000 samples was conducted.

Although concisely, the overall regression model showed no significance (R^2 = .182, F *(3, 37)* = 2.749, p = .056). As in subsample 1, this indicates a bad model fit. The null hypothesis was not rejected.

Outcome IOS, Subsample 1. Standardised residuals are right skewed (min = -1.61, max = 2.13). However, Shapiro Wilk test was insignificant (W = .960, p = .159), indicating normality. Scatterplot of standardised residuals and standardised predicted values indicates homoscedasticity and linearity. Computed collinearity statistics in predictors did not show any signs of collinearity (Mimicry, *Tolerance* = .368, *VIF* = 2.721; inversed partner's laughs, *Tolerance* = .718, *VIF* = 1.393; interaction, *Tolerance* = .463, *VIF* = 2.162). To account for the small sample size, bootstrapping of 1000 samples was conducted.

The overall regression model showed no significance with a very high p-value (R^2 = .052, *F (3, 37)* = .683, *p* = .568), implying the model to be a bad fit for the data. Thus, null hypothesis was not rejected.

Outcome IOS, Subsample 2. Standardised residuals are right skewed (min = -1.61, max = 2.04). Shapiro Wilk test was insignificant, although only concisely (*W* = .945, *p* = .063). Plotted standardised residuals with standardised predicted values showed no pattern, indicating homoscedasticity and linearity. Computed collinearity statistics in predictors did not show any signs of collinearity (Mimicry, *Tolerance* = .497, *VIF* = 2.013; inversed partner's laughs, *Tolerance* = .497, *VIF* = 2.011; interaction, *Tolerance* = .575, *VIF* = 1.741). To account for the small sample size and any assumption violations, bootstrapping of 1000 samples was conducted.

The overall regression model showed no significance with a very high p-value (R^2 = .010, *F (3, 34)* = .112, *p* = .952)., indicating that the model was a bad fit for the data. Thus, null hypothesis was not rejected.

Exploratory Analyses

Gender differences. Results of hypothesis 1 showed a significant relationship between laughs and partner's affiliation judgment. By adding sex to the regression equation in the second hypothesis, this relationship was not significant anymore. Therefore, we explored possible gender differences in independent and dependent variables of H1. As observable in

Figure **1** and Figure 3, women might have both laughed more and rated their partner higher in liking questions than men did. To test differences of men and women in count of laughs, the normality of residuals was checked. For both subsamples, Shapiro-Wilk tests did not imply normality in laughs (SS1, *W* = .925, *p* = .010; SS2, *W* = .944, *p* = .044). Thus, Mann-Whitney U-tests were conducted. Results are depicted in Table 6. In both subsamples, women had higher mean ranks than men. Laughs of subsample 2 resulted insignificant, but its p-value was still below 10%, and mean ranks directed towards similar numbers as in subsample 1. This result still leaves room for the interpretation of women to generally having laughed more than men.

Table 6

Mann-Whitney U-tests comparing women with men in count of laughs.

	Mean Rank of Women (n = 23)	**Mean Rank of Men** (n = 18)	***U***	***Z***	**Asymp. *p* (2-tailed)**
SS1	24.52	16.50	126.0	-2.131	.033
SS2	23.87	17.33	141.0	-1.736	.083

Note. Dependent variable is count of laughs in both subsamples.

For liking as dependent variable, the residuals of subsample 1 were normally distributed (W = .970, p = .339), whilst subsample 2 showed nonnormality (W = .905, p = .002). To account for failed assumptions of normality in one of the subsamples, Mann-Whitney U-tests were conducted. The results are listed in Table 7. Mean ranks of both subsamples were similar to each other, with women scoring higher. In both subsamples, women rated each other significantly more positively than men did.

Table 7

Mann-Whitney U-tests comparing women with men in partner's liking.

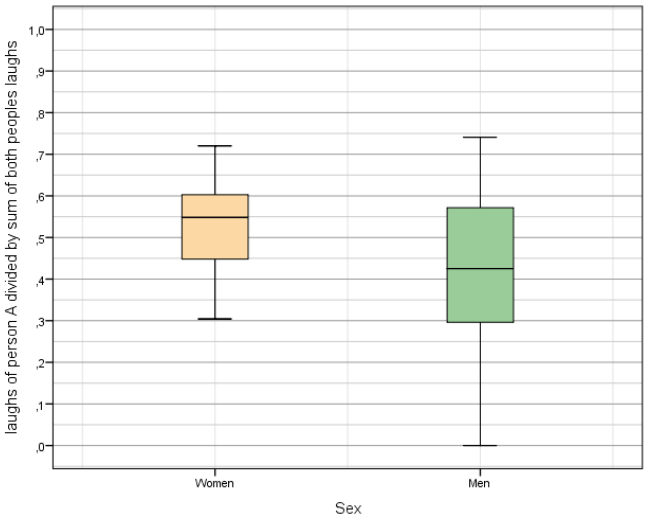
	Mean Rank of Women (n = 23)	**Mean Rank of Men** (n = 18)	***U***	***Z***	**Asymp. *p* (2-tailed)**
SS1	25.48	15.28	104.0	-2.724	.006
SS2	24.33	16.75	130.5	-2.022	.043

Note. Dependent variable is partner's sum of liking answers.

Mimicry and Contagion. As computations of H3 failed to find a sex difference in laughter mimicry, we investigated the general alignment of each other within a dyad. By dividing laughs of one person by the sum of laughs within a dyad, we created a ratio depicting how aligned both participants were with each other in laughter frequency. Results are depicted in Figure 6. The nearer the ratio is to .5, the more similar were the numbers of laughs with each other. Median of women is nearer to .5 and the dispersion around .5 is more compressed, indicating that women might have been more aligned in laughing behaviour than men. However, as only men laughed 0 times, and as they laughed less in general (Table

6), variability might also result because of a general lower base rate. Also, the potential difference of laughter alignment was not statistically tested.

Figure 6



Note. These boxplots show laughter variability between partners. The nearer to 0.5, the more both partners were aligned in how many laughs they produced.

Discussion

This study investigated a potential relationship between laughing behaviour and affiliation in free interactions between two people of the same sex. Specifically, gender differences in the relation between laughter frequency and affiliation judgments (first research question) as well as gender differences in laughing behaviour (second research question) was looked at. The study utilised data of a free interaction phase of another research project, in which 18- to 25-year-old same sex dyads played games and interacted with each other in a laboratory setting.

In our first research question, we aimed to investigate the relationship between laughter frequency and affiliation judgments. Here, in both randomly created subsamples, the number of laughs of one person could significantly predict their partner's affiliation judgment after the interaction. The more someone laughed, the more positively they got rated by their partner. The second hypothesis predicted an interaction effect of gender on the relationship between laughter and liking. Here, no interaction was found. Adding sex to the equation, influence of laughs resulted to be insignificant. Thus, results of the first hypothesis

and general gender differences in both laughter and likeability judgments are discussed critically.

In our second research question, we investigated laughter mimicry and its relationship with gender and affiliation. No behavioural gender difference in laughter mimicry was found. Also, laughter mimicry did not predict partner's liking judgments or feelings of closeness after the interaction significantly. Yet, it is important to consider several limitations of this study in order to not reject the stated hypotheses erroneously.

Limitations

The Influence of Gender on Laughs and Partner's Liking

As assumed in H1, regression analyses showed significant effects of laughs on partner's likeability judgment in both subsamples. However, adding sex to the regression model reduced significance of laughs influence on partner's liking, so that in computations of H2, laughs did not sufficiently explain any variance anymore. But, in both subsamples, the confidence interval of bootstrapped laughs was majorly in the positive range, indicating the same trend as in H1. However, as in subsample 2 the whole regression model was concisely insignificant, no definite conclusions can be drawn. Which of the subsamples is nearer to true values is unclear, as dyad splitting was only conducted once and without bootstrapping.

One limitation is our sample size. As shown in a priori power calculations, to find small effects, several hundreds of participants would be needed, which was not the case in our study. Women might laugh more in interactions than men, and also generally give more positive judgments towards each other. Exploratory analyses showed that in subsample 1, women laughed significantly more than men. Subsample 2 showed an effect into the same direction with a concisely insignificant outcome (Table 6). For liking, women significantly judged each other more positively than men in both subsamples (Table 7). Hence, a strong direct relationship of sex to both variables could have cancelled out a very small direct effect of laughter onto partner's liking just because of the small sample.

In addition to that, size of the effect could have even been underestimated. Looking at data distribution of both subsamples (Figure 5), a linear regression might not be the best fitted model. Floor effects of laughter and ceiling effects of liking seem to be the reason, leading to a rather triangle shape. This could have influenced both the effect size in H1 as well as the insignificant effect of laughs on liking in moderation analyses of H2. With a

wider scale of liking and longer interaction time, the distribution might be of a clearer linear shape.

Apart from that, operational limitations of laughter coding must be considered to having influenced the outcome. When coding laughter, intensity and length of laughter was not considered. Hence, if somebody laughed in short grunts, it was considered one laugh as much as someone who laughed three seconds long and very intensely. Also, longer periods of laughs were coded by indicating one coherent segment of laughter, when laugh pauses were perceived as 300ms or below. Because women generally produced more laughs, they might also have produced more multiple laughs that were coded as only one. Thus, count of laughs could be underestimated especially in women.

Laughter Mimicry, Affiliation, and Behavioural Gender Differences

Although overall data points towards the in H3 proposed direction of women mimicking more than men (Figure 2), regression models did not show significant sex differences. Also, against our proposition in H4, no relationship between laughter mimicry and partner's liking and feelings of closeness statements were found.

For a priori power analyses, we used effect sizes of prior studies with behavioural mimicry. As laughter is an already generally contagious and very specific emotional expression, effects of laughter mimicry might be a lot smaller than in behavioural mimicry. Smaller effects need larger sample sizes to gain the same amount of power. Hence, to find small effects, a lot more participants might have been needed.

Additionally, the absence of gender difference in mimicry might underlie operational limitations. As stated above, multiple laughs with pauses of less than 300ms were considered one coherent laugh. This means that, when both people exchanged several laughs with very short breaks in between, mimicry was not coded within the segment, but only once in the beginning of the whole segment. As women laughed more in general (Table 7), this limitation probably influenced women's mimicry outcome more than men's outcome. Thus, women might have mimicked more in total than our coding leads to believe.

Also, while coding, different types of contagion or mimicry were observed. One very common type was of person A intensifying their laughter, as soon as person B had joined in. However, here, only person B was identified to having mimicked. This type of mimicry possibly took place more often in people that had a higher count of laughs. Thus again, less mimicry could have been recorded in women as they exchanged more laughter in general. Accordingly, results did not cover the range of possible types of laughter contagion and alignment.

In order to further look into contagion, we created a graph that shows general alignment of number of laughs between dyad members. Figure 6 indicates a lower variability of laugh quantity within female dyads. However, this observation was not statistically tested. Another way to operationalise laughter contagion or alignment would be to measure the temporal overlap of laughter and e.g. compare it with non-overlapped time of laughter. Vanoncini et al. (2022) give good examples in research of affect synchrony that could be transferred to laughing behaviour. They quantified overlaps of emotional expression by measuring both rate of occurrence and variation of interval lengths. This operationalisation of synchronous behaviour might be the key to better understanding contagion and alignment in laughter.

General Limitations

Apart from the specific problems mentioned above, several general limitations of this study must be addressed that compromise interpretation of results. First of all, data is derived from the project Laughing Together, a laboratory study investigating interpersonal synchrony. Although the free interaction itself was attempted to occur as naturally as possible, participants were in a room full of technical devices and with fNIRS on top of their heads, discriminating the situation from a day-to-day conversation in an environment strangers tend to get to know each other. This compromises generalisability of results. Also, before the free interaction phase, cloze texts were filled out and animal videos were watched together. Thus, a lot of interaction happened before the free interaction that could have had additional influence on laughing behaviour and liking or even more influence than the behaviour within free interaction itself.

An additional limitation is the sample. As already stated above, small sample size of the subsamples leads to low power (see also: Data Collection and Analysis). This reduction of probability of getting significant effects, paired with probably small effects, might have led to the several insignificant outcomes. Moreover, the *sample composition* limits interpretation: Recruiting techniques resulted in a convenience sampling of Austrian and German students, majorly of psychology. Although technically not knowing each other, participants knew of each other to be in the same living and societal situation, which possibly had direct effects on social interactions and affiliation. Also, a homogenous cultural and societal background impedes the possibility of generalisation, and future research on gender differences with another sample composition or culture group might result differently.

Another problem already addressed in a priori analyses is the failed assumption of independent observations. Although none of the variables in significant results differed between IL and IC, still, correlations in error terms within the conditions have to be assumed. This usually leads to higher standard errors, leading to higher likelihood of false positive results. Therefore, significant results, such as in H1, have to be considered to be biased.

The probably biggest limitation of this study is about its nature of interactional data. Here, the problem of dependence of dyad members was addressed by splitting the dyads. However, although randomised, splitting the dyads was only computed once. Instead, the split should have been bootstrapped in order to gain an estimate nearer to true values. Therefore, found effects need to be considered with caution, and differing results between subsamples leads to non-interpretability.

Furthermore, the method of splitting dyads is very limited in gaining a bigger picture of what is happening in an interaction between two people. Especially laughing behaviour as a social-emotional communicative tool possesses the problem of interdependent contagiousness and reactiveness (Scott et al., 2022). Subjects, who already liked a person a lot initially, might also have laughed more in the interaction part, leading to more laughter contagion in the other person. Also, one's own laughter can be assumed to influence how much subjects liked the other person, as usually own affect influences perception of others' emotional states (Schmid & Schmid Mast, 2010; Trilla et al., 2021; Von Mohr et al., 2020), consequently resulting in a more positive impression of their partner.

Implications of Using Same-Sex Pairs

The project LT is designed to observe same-sex dyads. As this study is an interactional study, other gender effects could have interfered if mixing the dyads. Social interactions between genders seem to follow different mechanisms. In a study by Chapman and Foot (1976), girls laughed more with boys than with girls. This difference might demonstrate heteronormative socialisation and internalised mechanisms of behaviour in a heteronormative society - even without sexual attraction (e.g. Gansen, 2017; Van Der Toorn et al., 2020). Different interaction patterns and laughing behaviour in mixed-sex pairs compared to same sex pairs could have thus blurred the investigated effects.

Moreover, studies suggest that same-sex dyads should not interfere with finding an effect if hypotheses of our study apply. In the previously mentioned study of voiced and unvoiced laughter recordings by Bachorowski and Owren (2001), female laughter received more extreme ratings in friendliness, own affective response, and interest in meeting by *both*

female and male listeners. An interaction effect with sex of the listener only took place with sexiness and laugh-track ratings. Hence, stereotypes seem to be used by both sexes for affiliation judgments. Thus, if existent, an effect of gender stereotypes on laughter and liking should have been detectable by only researching same sex dyads as well. Furthermore, behavioural gender differences should also have been detectable within same-sex dyads if existent, as Dimberg and Lundquist found that the difference of facial expression mimicry in women and men was not affected by gender of the presented face (1990). However, with same-sex dyads, the outcome cannot be generalised, and differing bonding mechanisms between the sexes might have influenced outcomes as well.

Why are there Gender Differences in Laughs and Likeability Judgments?

Several reasons might contribute to the found gender difference in likeability judgments as well as in count of laughs. Findings show that men need to smile more in order for their facial expression to not getting judged as angry (Harris et al., 2016). This could have had an impact on likeability judgments in male dyads. Also, following social role theory and longitudinal findings, women are socialised into promoting social harmony and fostering social connections (Block, 1984; Eagly, 2013; Eagly & Wood, 1991). In Big Five, these attributes can be found in agreeableness, which is found to be higher in women, too (Costa et al., 2001; Weisberg et al., 2011). Hence, agreeableness or a greater need for social harmony could also be a variable that influences sex differences in both laughter and liking judgments.

Yet, another explanation for found gender differences in liking and laughing could apply. As the data consisted of same sex dyads, gender differences found in this study might as well point towards how same sex bonding works differently in men than in women (Maccoby, 2002). Vigil (2007) found that men usually maintain relationships for large and functional coalitions, while women tend to maintain fewer, but more intimate and secure relationships. In a review by Rose & Rudolph (2006), several differences in same sex bonding of girls and boys were compiled. Girls' interactions are more prosocial, communicative, and intimate, they are more likely to seek support, express their emotions, and they also receive higher levels of emotional provisions in their same sex friendships. In contrast, boys rather interact in larger groups with stricter dominance-hierarchies and competitive play, and they receive fewer emotional provisions in their friendships. Also, boys tend to emphasise more self-interest and dominance goals, while girls rather have connection-oriented goals. Many of these differences in bonding and friendship style tend to

increase developmentally, indicating the societal and normative influence on how men and women learn to bond.

These findings align with qualitative observations of Way (2011), who found that there is a definite cut of very affectionate descriptions of male friendships in childhood, developing into less emotional and rather competitive friendships in adolescence. Way ascribes this development to social norms of a heteronormative society, that prohibits affection and intimacy between two men and shifts any fulfilments of emotional needs onto relationships with women. Differences in seemingly trivial variables such as likeability judgments or laughing behaviour with strangers might be part of the bigger picture of men being socialised into not showing too much affection towards each other.

Future Research: Dyadic Data Modelling

As explained above, the problem of interdependence of the dyads was addressed by splitting the dyads and computing each regression twice. However, laughing of one person in an interaction between two people cannot be looked at independently without also looking at laughing of the other person. Several models have been established to take dyadic data structure into account (Iida et al., 2018). Because of our interest in individual data within an interdependent dyadic structure, a widely used model called Actor-Partner-Interdependence Model (APIM; Kenny, 2018; Kraemer & Jacklin, 1979) would be the perfect fit for further investigations. In this model, possible confounding variables regarding interdependent influence of one another within a dyad is being addressed. The model differs between actor effects (How does my own laughter influence the outcome?), partner effects (How does my own laughter influence the outcome of my partner?) and can additionally compute interaction effects between actor and partner (How is the outcome influenced by both people laughing?). Also, APIM can detect the specific type of dyad pattern – equal effects of both, contrasting effects, or no partner effects on the outcome - by estimating the parameter *k* (Kenny & Ledermann, 2010). There are two possible applications of APIM: One using a multilevel model (MLM) with fixed effects, and one within a structural equation model (SEM). Choice of application depends on sample size and distinguishability within the dyads – e.g. same sex dyads in contrast to hetero couples. In our case with same sex dyads, MLM is argued to be the better option (Ledermann & Kenny, 2017). If differing-sex dyads are to be investigated, SEM might be more suitable.

Although several shiny apps have already been built to provide feasibility, access is still impeded for young academics that are not acquainted with higher computations and

programming. One example is APIM_MM (Kenny, 2015), a computer software built on multilevel modelling. This software provides a big range of options to choose from and one can run several different computations. Normalised residuals are given as output, and if residuals are highly skewed or there are ceiling or floor effects, warnings are displayed. However, no standardised residuals or predicted values are derived from the computation. Therefore, essential assumptions such as homoscedasticity and normality of residuals cannot be checked within the software. We propose supplementing softwares with built-in assumption checks or an output of residuals and predicted values, in order to gain feasibility of APIM.

Conclusion

Concerning the first research question, the assumed relationship between laughter frequency and affiliation judgments is not clear, as gender seems to serve as a confounding variable. Further studies with bigger sample sizes might clarify whether or not still a direct relationship exists. No interaction effects of gender were found in this study, indicating that gender stereotypes have no influence on the relation of laughter frequency and likeability judgments. This finding does not necessarily contradict prior findings of gender stereotypes influencing affiliation judgments. In present research, only quantity of laughter was investigated, but in prior studies, *qualities* of laughter were found to differ between the sexes (Bachorowski et al., 2001; Grammer & Eibl-Eibesfeldt, 1990), and those seem to influence gender stereotypical affiliation judgments (Bachorowski & Owren, 2001). Thus still, further investigations are needed to investigate the exact relationship of laughter, gender, and affiliation judgments.

Regarding the second research question, no relationship between laughter mimicry and affiliation or feelings of closeness was found. Also, no sex differences were found in laughter mimicry. However, operationalisation and sample size might have limited the outcome. Although not observable via mimicry, further investigation with differing operationalisation might lead to a better understanding of laughter contagion, including possible differences between men and women. Also, laughs as a different variable of behaviour has differed between the sexes, indicating that further studies are needed to better understand other effects of gender onto laughing behaviour.

Besides, in this study gender differences in laughter frequency and likeability judgments were observable. Its reasons and exact relationship with each other remain unclear. Especially for same sex dyads, we propose further studies on those behavioural gender differences to get a deeper understanding of cultural and societal implications, as well

as to grasp influences of heteronormative upbringing on laughter and bonding in interactions. In addition, also cross-sex dyadic interactions should be explored in order to gain more insight into possible general effects of laughter and affiliation.

Laughter is such a variable social tool and emotional expression, that no general conclusions can be drawn. We propose further studies with stated methods for dyadic data structures, but also more detailed qualitative research regarding different types of laughter and their occasions. Laughter is one of the fewer researched emotional expressions, and with its social intertwining, there is still a lot unknown and to be investigated.

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List of Abbreviations

APIM	Actor-Partner Interdependence Model
DO	Degree of Organization
fNIRS	Functional near-infrared spectroscopy
H1 / H2 / H3 / H4	Hypothesis 1 / 2 / 3 / 4
IOS	Inclusion of Other in the Self Scale
LT	Laughing Together
MLM	Multilevel modelling
SEM	Structural equation modelling
SS1 / SS2	Subsample 1 / Subsample 2

Appendix

A. Abstract

Laughter is a universal human nonverbal vocalisation that serves as an expression and communication of emotions. Because of its contagiousness and high occurrence in social settings, laughter is believed to foster cooperation and bonding. As societal expectations regarding the display of affiliative behaviours differ between sexes, we propose an influence of gender on the relationship between laughter and affiliation. In this study, we aimed to examine these influences in two aspects. Firstly, we explored how a potential association between laughter frequency and affiliation judgments by their interaction partner is influenced by gender of the laugher. Secondly, we investigated potential behavioural gender differences in laughter mimicry and examined its association with interaction partner's affiliation as well as feelings of closeness. The study utilised the free interaction phase of a laboratory study with 41 same-sex dyads of 18- to 25-year-old unacquainted participants. Questionnaires were administered to measure participants' liking of their interaction partner and feeling of closeness towards them. Additionally, laughing behaviour and laughter mimicry were recorded and manually coded. Results were analysed using regression and moderation analyses. No interaction effect of gender on the relationship between laughter frequency and affiliation judgments was found. Also, no relationship between laughter mimicry, partner's affiliation and feelings of closeness was found. However, differences between genders in laughing behaviour as well as affiliation judgments were present. Small sample size and several statistical limitations might have biased the outcome. To gain a better understanding of how gender influences the dynamics of laughter and its impact on social connections, further studies are necessary.

Keywords: *laughter, affiliation judgment, liking, bonding, stereotypes, gender differences*

B. Zusammenfassung

Lachen ist eine universelle menschliche nonverbale Vokalisierung, die dem Ausdruck und der Vermittlung von Emotionen dient. Da Lachen ansteckend ist und vor allem in sozialen Situationen vorkommt, wird vermutet, dass es Kooperation und zwischenmenschliche Bindungen fördert. Da es geschlechtsspezifisch unterschiedliche gesellschaftliche Erwartungen in Bezug auf beziehungsorientierte Verhaltensweisen gibt, vermuten wir einen Einfluss von sozialem Geschlecht auf die Beziehung zwischen Lachen und Bindung. Zwei verschiedene Aspekte dieses Einflusses haben wir in dieser Studie untersucht: Erstens hat uns interessiert, wie das soziale Geschlecht der lachenden Person eine potenzielle Assoziation zwischen Lachfrequenz und Sympathiebewertungen des Gegenübers beeinflusst. Zweitens haben wir Geschlechtsunterschiede im Verhalten bei Lach-Mimicry, sowie einen Zusammenhang von Lach-Mimicry mit Sympathie und Nähegefühlen des Gegenübers untersucht. Diese Studie nutzte Daten der freien Interaktionsphase einer Laborstudie von 41 gleichgeschlechtlichen sich fremden Dyaden zwischen 18 und 25 Jahren. Zum Messen von Sympathiebewertungen des Gegenübers und Nähegefühlen zueinander wurden Fragebögen genutzt. Lachverhalten und Lach-Mimicry wurden aufgenommen und manuell kodiert. Die Ergebnisse wurden mithilfe von Regressions- und Moderationsanalysen berechnet. Keine Interaktionseffekte von Geschlecht auf den Zusammenhang zwischen Lachen und Sympathie wurden gefunden. Auch wurde kein Zusammenhang zwischen Lach-Mimicry, Sympathie und Nähegefühlen gefunden. Jedoch gab es geschlechtsspezifische Unterschiede bei Lachfrequenz und Sympathieangaben. Die Stichprobengröße und verschiedene statistische Limitationen könnten das Ergebnis verzerrt haben. Um ein besseres Verständnis von sozialem Geschlecht in Bezug auf Dynamiken von Lachen und seinen Einfluss auf soziale Beziehungen zu finden, sind zukünftige Studien notwendig.

Schlagwörter: *Lachen, Sympathiebewertung, Sympathie, Bindung, Stereotypen, Geschlechtsunterschiede*

C. Descriptive Information Tables

Table C1

Descriptive Information for Laughing Behaviour

	N	M	SD	Min	Max
			Subsample 1		
Men	18	14.33	9.89	0	33
Women	23	26.04	16.44	6	66
Total	41	20.90	14.99	0	66
			Subsample 2		
Men	18	17.17	10.98	3	41
Women	23	22.57	10.74	7	46
Total	41	20.20	11.05	3	46
			Total		
Men	36	15.75	10.40	0	41
Women	46	24.30	13.84	6	66
Total	82	20.55	13.09	0	66

Note. Number of laughs produced in 10 minutes of free interaction.

Table C2

Descriptive Information for Laughter Mimicry in Free Interaction Phase.

	N	M	SD	Min	Max
			Subsample 1		
Men	18	4.72 / 12.44	4.55 / 8.47	0 / 3	15 / 29
Women	23	7.61 / 14.96	6.65 / 6.80	0 / 4	27 / 29
Total	41	6.34 / 13.85	5.94 / 7.58	0 / 3	27 / 29
			Subsample 2		
Men	18	4.56 / 9.78	4.96 / 7.52	0 / 0	20 / 20
Women	23	7.96 / 18.08	4.88 / 12.96	1 / 3	19 / 52
Total	41	6.46 / 14.43	5.14 / 11.57	0 / 0	20 / 52
			Total		
Men	36	4.64 / 11.11	4.69 / 8.01	0 / 0	20 / 29
Women	46	7.78 / 16.52	5.77 / 10.36	0 / 3	27 / 52
Total	82	6.40 / 14.15	5.52 / 9.72	0 / 0	27 / 52

Note. Count of mimicked laughs / Count of non-mimicked laughs

Table C3

Descriptive information for Likability Judgments after free interaction phase

	N	M	SD	Min	Max
			Subsample 1		
Men	18	17.83	3.62	12	24
Women	23	20.83	2.01	18	24
Total	41	19.51	3.17	12	24
			Subsample 2		
Men	18	17.33	4.09	6	22
Women	23	19.78	3.73	12	24
Total	41	18.71	4.03	6	24
			Total		
Men	36	17.58	3.81	6	24
Women	46	20.30	3.01	12	24
Total	82	19.11	3.63	6	24

Note. Likeability judgments by corresponding interaction partner. Sum of three questions on a scale of 0 – 8 with higher scores indicating a more favourable answer.

Table C4

Descriptive information for IOS after free interaction phase

	N	M	SD	Min	Max
			Subsample 1		
Men	18	3.11	1.13	1	5
Women	23	2.64	1.05	1	5
Total	41	2.88	1.10	1	5
			Subsample 2		
Men	18	2.89	.90	1	5
Women	22	2.45	1.10	1	4
Total	40	2.65	1.03	1	5
			Total		
Men	36	3.00	1.01	1	5
Women	45	2.58	1.08	1	5
Total	81	2.77	1.06	1	5

Note. Feelings of Closeness by corresponding interaction partner. Single-item Likert scale between 1 and 5 with higher scores indicating a more favourable answer.

D. Liking Questionnaire in German

(Lakin & Chartrand, 2003)

Bitte beantworte die folgenden Fragen.
Auf einer Skala von 0 (trifft gar nicht zu) bis 8 (trifft sehr zu)

Wie wohl fühlst du dich mit der anderen teilnehmenden Person?

0 1 2 3 4 5 6 7 8

Wie sympathisch ist die andere teilnehmende Person?

0 1 2 3 4 5 6 7 8

Würdest du gerne mehr Zeit mit der anderen teilnehmenden Person verbringen?

0 1 2 3 4 5 6 7 8

E. IOS in German

(Aron et al., 1992)

Inclusion of Other in the Self Scale (IOS)

Du siehst unten sieben Kreispaare, die sich gerade berühren oder fast vollständig überlappen. Ein Kreis in jedem Paar ist mit "Self" (= du selbst) beschriftet, der zweite Kreis mit "Other" (der/die Andere). Du sollst eines der sieben Paare auswählen, um folgende Frage zu beantworten: "Welches Bild beschreibt Ihre Beziehung zu der Person gegenüber am besten?"