Computers in Human Behavior 161 (2024) 108391

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Facial behaviour and first impressions in computer mediated communication

Jasmine Rollings *, Eithne Kavanagh, Alisa Balabanova, Olivia Keane, Bridget M. Waller

Department of Psychology, Nottingham Trent University, Nottingham, UK

A R T I C L E I N F O

Keywords:
Facial behaviour
Online communication
Face-to-face communication
Social interaction
Personality
Social outcomes

A B S T R A C T

Online video social interaction is now commonplace following rapid technological advances and the Covid-19 pandemic. Whether computer mediated communication (CMC) fundamentally changes nonverbal behaviour and social responses from others is unknown. Here, we conducted a repeated measures experimental study (N = 66) comparing three types of dyadic social interactions: in person, online video call (with self-view) and online video call (no self-view). Facial videos were analysed using automated facial movement tracking (based on the Facial Action Coding System: FACS). Independent raters made first impression judgements across all conditions (N = 198). Overall, people were more facially expressive in person compared to CMC, but there were significant individual differences across participants. Agreeableness was associated with a particular increase in expressivity in person compared to online, while extroversion was associated with greater expressivity in online video calls, but only when self-view was visible. Older adults were most impacted by CMC and showed the greatest reduction in facial expressivity online compared to in person. The first impressions of observers did not differ as a function of CMC. These results suggest that CMC does alter facial expressivity during social interaction, but that there is an important interplay with individual differences.

1. Introduction

Advances in technology, desire for flexible working patterns, and the COVID-19 pandemic has resulted in an increased reliance on computer mediated communication (CMC). Indeed, people now communicate more often online than offline (Lieberman & Schroeder, 2020). With the advent and current escalation of online communication, it is important to discover whether there are any behavioural differences between online and face-to-face communication, and how this may affect the social interaction between those engaging in these interactions.

Video calls are essentially a proxy for live interaction, but there are several key structural differences between in-person and online video interaction (Lieberman & Schroeder, 2020). For example, compared to face-to-face in-person interactions, online interactions constrain certain nonverbal cues; eye contact is often not possible or inhibited, it is possible for time-lags to occur and disrupt turn taking, and monitoring third party nonverbal interactions is much more difficult or impossible. Given these seemingly fundamental differences, it could be expected that people experience different outcomes depending on the online or in-person setting. However, this does not always seem to be the case. A recent meta-analysis concluded that internet based cognitive behavioural therapy (ICBT) had equivalent overall treatment effects as face-to-face treatment (Carlbring, Andersson, Cuijpers, Riper, & Hedman-Lagerlöf, 2018). Similarly, in the domain of higher education, similar learning outcomes can be observed between online and face-to-face (FTF) university teaching programmes (Stevens, Bienz, Wali, Condie, & Schismenos, 2021). Social science researchers have also found that during qualitative interviews with study participants, rapport and disclosure does not decrease in video compared to face-to-face interviews (Weller, 2017). In terms of first impressions, CMC via text messaging can result in lower scores on affiliative outcomes between pairs of strangers than face-to-face, but richer types of CMC such as audio or video conversation can lead to similar social outcomes (Sprecher, 2014).

On the other hand, some studies have found that interacting in-person can have immediate positive effects that are greater than if one had interacted online. For example, in a 'live-time' study that prompted participants to respond about their current interaction type (between in-

* Corresponding author.
E-mail addresses: jasmine.rollings@bristol.ac.uk (J. Rollings), eithne.kavanagh@ntu.ac.uk (E. Kavanagh), alisa.balabanova2021@ntu.ac.uk (A. Balabanova), oliviakeane20013@gmail.com (O. Keane), bridget.waller@ntu.ac.uk (B.M. Waller).

https://doi.org/10.1016/j.chb.2024.108391
Received 31 October 2023; Received in revised form 16 July 2024; Accepted 31 July 2024
Available online 6 August 2024

person, online, and no interaction) adolescents reported experiencing greater positive affect and less loneliness from in-person interactions (Achterhof et al., 2022). First impressions may be more positive following face-to-face interactions: in a social interaction laboratory study participants who interacted face-to-face reported liking their partners more than participants who interacted in a text-based chat (Okdie, Guadagno, Bernieri, Geers, & Mclarney-Vesotski, 2011). In short, therefore, the evidence is mixed as to whether social outcomes are more positive for online versus face-to-face interaction.

If social outcomes are impacted by CMC, what is the underpinning mechanism? Facial behaviour is understood to play a pivotal role in interpersonal communication. Faces are functional tools for social interaction, used to influence the target audience and thus the outcome of the social interaction (Crivelli & Fridlund, 2018; Fridlund, 1994) and as predictors of potential social action (Waller, Whitehouse, & Micheletta, 2017). Consistent with this perspective, conditions known to affect facial expression production are often linked to challenges in social interactions. For instance, individuals experiencing peripheral facial palsy, a condition affecting facial muscle control, can feel apprehension in social situations (Cuenca-Martínez, Zapardiel-Sánchez, Carrasco-González, La Touche, & Suso-Martí, 2020). Moreover, diminished expressivity has been correlated with reduced social competence and peer liking ratings in certain clinical conditions, such as schizophrenia (Brüne, Abdel-Hamid, Sonntag, Lehmkämper, & Langdon, 2009) and autism (Stagg, Slavny, Hand, Cardoso, & Smith, 2014). Given the central role of faces in social communication (Jack & Schyns, 2017), if there are differences in facial behaviour across in person and CMC contexts this could result in different social outcomes.

In online interactions facial behaviour may be particularly important, as the perceiver has fewer alternative visual cues (e.g., body movement, gesture). To date, only a singular study, to the best of the authors' knowledge, has investigated facial behaviour in both face-to-face and online contexts. This study, conducted as a controlled lab experiment, analysed eye gaze and facial motion. The participants engaged in one-on-one question and answer scenarios with a confederate: through a pre-recorded video, a live online interaction, or a face-to-face encounter (Cañigueral, Ward, & Hamilton, 2021). Participants exhibited similar eye gaze behaviour and facial movement in both the face-to-face and live online interaction settings. Though the authors of this study acknowledge that ecological validity may be lacking due to the controlled nature of the question-and-answer tasks, and they suggest that future work could utilise naturalistic social interactions. These findings suggest that facial behaviour may remain consistent in online and in-person interactions.

One particularly strange characteristic of interacting via video conferencing software is the ability to see your own face during the call. This form of video feedback may have profound implications for the experience and outcomes of social interaction. Considering the tendency for people to pay more attention to their own face over the faces of others (Tacikowski & Nowicka, 2010), it is possible that these differences may arise due to an attentional bias to look at their own face over looking at their social partner. Indeed, experimental comparisons of online interactions with and without self-view (e.g., Miller, Mandryk, Birk, Depping, & Patel, 2017; Shin, Ulusoy, Earle, Bente, & Van Der Heide, 2022) suggest that video feedback increases self-awareness and affects the content of the conversations between dyads (Miller et al., 2017). Furthermore, both self-perception and evaluations of the social partner can be affected by the presence of video feedback (Shin et al., 2022). So, the literature points to an increased self-awareness from the ability to self-view during social interactions, which may in turn have a negative influence on social outcomes. However, little is known about whether the ability to self-view affects how people produce facial expressions.

In this study, we investigated the impact of CMC on facial behaviour and social outcomes in unstructured dyadic social interaction. We compared social interactions between strangers in different settings: face-to-face, where the interaction took place in the same room, and video call, where participants took part in a Zoom meeting with their interaction partner (who was in another room of the same building). Due to the potential influence of being able to self-view, we included two video call conditions, one in which the individual could see their own face (as is the default call setting) and the other in which the individual could not see their own face. We predicted that facial behaviour and social outcomes would be similar between the face-to-face and non-feedback video call conditions, but that facial behaviour would differ in the feedback video condition due to ability to self-monitor. As some personality types seem to adapt to online interaction more so than others (e.g., Spradlin, Cuttler, Bunce, & Carrier, 2019) it is possible that self-monitoring interacts with personality traits to affect interpersonal performance (Barrick, Parks, & Mount, 2005). The interaction between CMC and personality could be particularly relevant when considering online interaction types, as certain traits such as shyness have led people to behave differently when they could see themselves compared to when they could not see themselves in online chats (Brunet & Schmidt, 2007). There is some evidence that personality is associated with general differences in the production of nonverbal behaviour. For example, one exploratory analysis showed an association between walking gait and the Big Five traits (Satchell et al., 2017). Extraversion was associated with more lower body movement, and conscientiousness with more upper body movement, suggesting that personality is embodied in walking behaviour. Likewise, research using Electronically Activated Recorders (EAR), an audio recording method for the real–world measurement of daily behaviour, has found some associations between nonverbally expressive behaviour and personality (Tackman et al., 2020). During real-world social interactions, extraversion has been associated with more laughter and more angry vocalisations, agreeableness with more yawning, conscientiousness with less singing and sighing, neuroticism with more laughing, crying, angry vocalisations, singing, sighing and yawning, and openness with less crying, angry vocalisations and yawning. However, while there is some evidence that facial expression production is linked to personality (see Keltner (1996) for a review of early work), large scale empirical work documenting facial movements during real-world social interaction are scarce. Thus, how personality relates to facial behaviour is still relatively poorly understood. Therefore, in this study we explore how individual differences relate to facial behaviour of participants in face-to-face and CMC conditions. Specifically, we investigated whether age, gender and the Big Five personality traits (John & Srivastava, 1999) relate to differences in facial behaviour across conditions.

2. Material and methods

2.1. Ethics

This study was reviewed by Nottingham Trent University Schools of Business, Law and Social Sciences Research Ethics Committee (application 2022/126) and met with a favourable ethics opinion.

2.2. Part 1: social interaction dyads

2.2.1. Participants

Sixty-six participants completed part 1 of this study (49 self-reported as female, 16 self-reported as male and 1 self-reported as nonbinary). Participants were informed that this research was studying communication between strangers and recruited by volunteer sampling through university student and public participant pools, and social media advertising. All participants were provided with an information sheet in advance to the data collection date and gave informed consent on the day of participation. Participants received a £10 shopping voucher as compensation for taking part and to cover travel expenses. Participants were asked to self-report their gender and age in open text fields, participants reported their gender to be either 'female', 'male' or 'nonbinary', therefore these terms will be used to describe participants throughout. No data on ethnicity or race was collected. The average age of participants was 34.2 (SD = 19.2) years; however, two distinct age groups were evident in the data: ages 18–38 years and 51–91 years, therefore in the analysis age is divided into adults (n = 51, of whom 36 reported they were female, 1 as non-binary and 15 as male) and older adults (n = 15, of whom 13 reported they were female and 2 as male).

2.2.2. Confederates

In this study participants interacted with one of eight confederates (2 men, 6 women) ranging in age from 19 to 60 years– who were members of the research team conducting the study. No data on ethnicity or race was collected from the confederates. Confederates were aware of the aims of the study and the condition they were in. The order of conditions was randomised across participants, and efforts were made to ensure that each confederate experienced an equal number of each type of interaction. This approach aimed to maintain balanced involvement across confederates in all conditions. Confederates and participant pairings were not sex-matched. Confederates received instructions similar to those given to participants: they were asked to engage in unscripted conversation about anything they would like for 3 min, the experimenter would then conclude the interaction once the time had elapsed and afterwards they would be asked questions about the interaction via a questionnaire.

2.2.3. Procedure

Each participant took part in three social interactions each lasting 3 min, in each interaction they engaged with a new person. The three social interactions took place under different conditions: face-to-face (FTF condition), on Zoom with the participants self-view camera switched off (Video Call (self-hidden)) and on Zoom with the participants self-view switched on (Video Call (self-visible)). In the Zoom call conditions, confederates always had their self-view camera switched on, they did not experience the self-hidden condition as participants did. In the FTF condition participants and interaction partners sat opposite one another at a small table, the seating arrangement was kept consistent across participants. For the Video Call conditions participants sat at a desk facing a computer screen with a webcam. The distance between the participant and the screen, and between the participant and the confederate will likely differ as this was not controlled. Fig. 1, below, outlines the lab layout with camera setup.

Participants were met by the experimenter in a waiting area, then led into the main lab (Room 1 on Fig. 1) where they read the information sheet and completed the consent form. Participants were given verbal instructions on how the study would operate and given the opportunity to ask questions. Participants were told that they would take part in three interactions, during each interaction they could discuss anything they would like for 3 min, the experimenter would then conclude the interaction once the time had elapsed and afterwards they would be asked questions about the interaction via a questionnaire. Participants completed the FTF condition seated in one room (Room 1) and both online conditions seated in a separate room (Room 2; see Fig. 1 for apparatus setup). The experimenter guided participants to the relevant room between conditions and escorted the confederate out of the lab under the pretence they would complete the remaining questionnaires in another room. Following the interactions, participants completed the questionnaire (firstly the interaction partner ratings, then demographics and the personality measure) hosted on the Qualtrics survey platform.

2.2.4. Measures

2.2.4.1. Big Five personality traits. The Big Five Inventory (BFI; John & Srivastava, 1999) is designed to measure the five major dimensions of personality, often referred to as the "Big Five" traits. These traits are Extraversion, Agreeableness, Openness, Conscientiousness, and

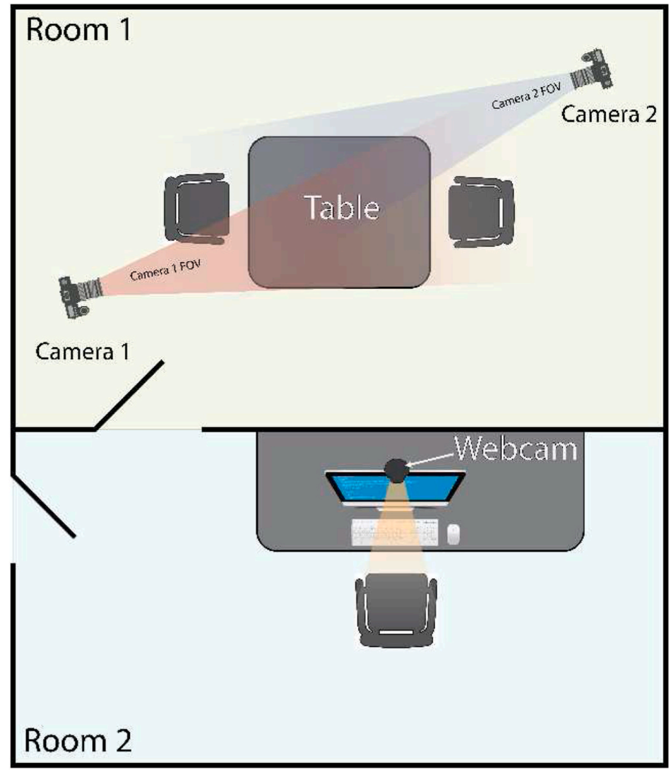

Fig. 1. Lab layout for the social interaction experiment. *Note.* Camera and webcam field of view (FOV) is shown by highlighted areas.

Neuroticism. The BFI has been employed in various fields, including psychology, sociology, and personality research. The BFI has many iterations, here we use the of 44-item scale. Respondents rate themselves on a Likert-style scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) with how much an individual item describes the answerer. An example of two items relating to neuroticism are "I am someone who … worries a lot" and "I am someone who … is relaxed, handles stress well", with the latter being reverse scored. Several items relate to each of the five dimensions, these are then scored, and an average score is calculated for each individual personality trait. The BFI-44 has been widely used for over three decades and has demonstrated good reliability and validity in numerous studies (Schmitt, Allik, McCrae, & Benet-Martínez, 2007; Soto & John, 2009).

2.2.4.2. Interaction partner ratings. Following the social interactions, participants and confederates answered questions about one another. Both confederates and participants were asked to indicate how much they liked their social partner (0–100), how much they wanted to engage in further conversation with them (0–100) and whether they would be friends with them (yes, no, maybe). Confederates were additionally asked to assess the expressivity and communicative competence of the participant (both 0–100) and to complete the Ten-Item Personality Questionnaire (TIPI; Gosling, Rentfrow, & Swann, 2003) about the participant.

2.2.4.3. Facial expressivity score. From the video data collected in the social interactions, visually detectable facial muscular movements were coded based on the Facial Action Coding System (FACS ; Ekman, Friesen, & Hager, 2002; Ekman & Friesen, 1978). FACS allows for the quantitative description of these muscle movements, called action units (AUs). We used automated facial behaviour coding software iMotions (iMotions Biometric Research Platform (SW Version), 2001) which coded the presence/absence of sixteen action units per frame from the video data (see supplementary).

Automated facial behaviour coding was chosen as it has high consistency with expert human coders (Benitez-Quiroz, Srinivasan, & Martinez, 2016; Girard, Cohn, Jeni, Sayette, & De la Torre, 2015) and is not prone to coding drift (wherein coders change their coding technique over time). Generally human coders will aim to achieve an inter-rater agreement level of 0.70 as set out by Ekman et al. (2002), although there is often a great deal of variation in inter-observer reliability across action units (e.g., 0.53–0.99 agreement in Sayette, Cohn, Wertz, Perrott, & Parrott, 2001). Automated coding also allows for the coding of more footage due to the much faster processing and training time - manual coding can take hours to code a single minute of video footage and requires coders to have extensive FACS training, with an estimated 100 hours of training to pass a certification test (Harrigan, Rosenthal & Scherer, 2008). The highest rates of agreement between human and automated coding are found in ideal lab settings (i.e., when the image was front facing, unobstructed and in good light), and so the present study was well suited to using this approach to facial coding.

From the AU data, we calculated six facial expressivity measures for each condition: rate, duration, repertoire, combination repertoire, corrected repertoire, and diversity score. Table 1, outlines how these variables are calculated, a more detailed description is available in (Kavanagh, Whitehouse, & Waller, 2024).

In each of the three conditions, the six facial expressivity measures correlated significantly (see supplementary materials). To reduce the dimensionality of the dataset and mitigate multicollinearity, we implemented three principal components analyses (PCA) on the six facial expressivity measures calculated in each of the three conditions. We used the 'psych' package (Revelle, 2017) to conduct the PCAs, using a varimax rotation. Inspection of scree plots and use of parallel analyses indicated that all variables loaded onto a single component (see supplementary materials). Therefore, all six facial expressivity variables were used to create an 'expressivity score' from each condition, which was calculated by taking a mean of the z-scores generated from each of the six facial expressivity measures (see Fig. 2).

Two participants were not able to be included in the facial analysis, in both cases the software iMotions could not reliably detect facial movement due to mask wearing and the lack of ability to detect facial landmarks. There was missing data for a further two participants, where one of the three conditions was missing a video recording due to recording errors; these participants are included in the analyses where possible.

2.3. Part 2: independent raters

2.3.1. Participants

198 participants (99 women, 99 men) were recruited via recruitment platform *Prolific.co*. Prolific was set to collect a balanced sample (even distribution of self-reported men and women) and to collect from participants who are fluent in English and currently located in the UK. Participants had to be over the age of 18 to take part, the average age of participants was 40.5 years, with an age range of 20–78 years. Participants were compensated for their time with a payment equivalent to the UK national living wage at the time of collection. Data was collected in July and August 2023.

Table 1
FACS Measures used to produce expressivity score.

MEASURE	CALCULATION
DIVERSITY SCORE	Measure of the N of unique AUs and how evenly they are represented. Calculated per condition using the formula from (Scheider, Liebal, Oña, Burrows, & Waller, 2014).
RATE	The N of AUs produced per minute in each condition.
DURATION	The percentage time each AU was produced in each condition was first calculated. The sum of values from all AUs was calculated per condition.
AU REPERTOIRE	The total number of unique AUs produced in each condition.
CORRECTED AU REPERTOIRE	The total number of unique AUs produced out of the first 25 AUs produced in each condition.
COMBINATION REPERTOIRE	The total N of unique AU combinations (i.e., simultaneous production of 2 or more AUs) in each condition.

Note. Adapted from (Kavanagh, Whitehouse, & Waller, 2024).

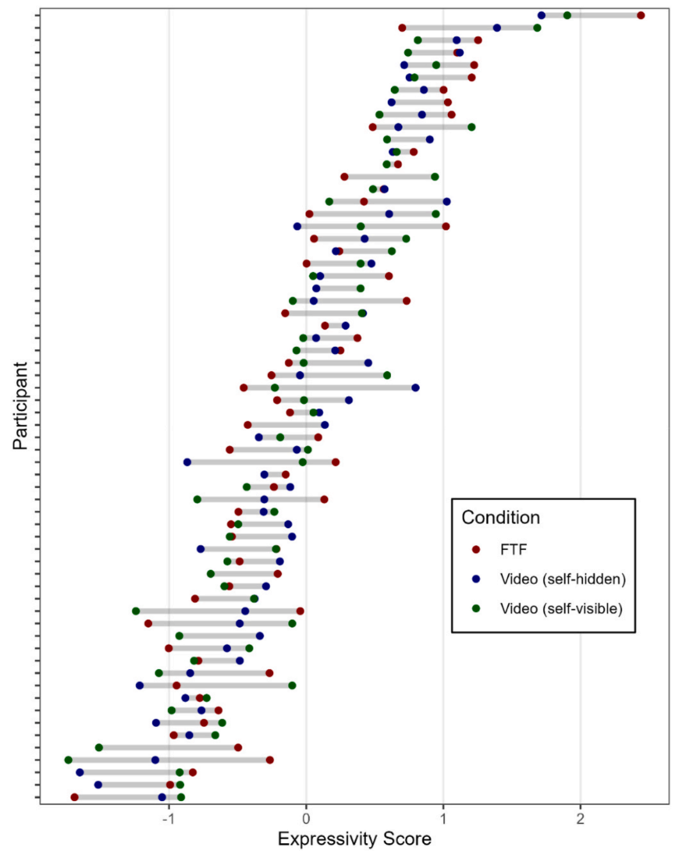

Fig. 2. Expressivity scores per participant across conditions. *Note.* Two participants were missing video data from one of the three conditions; they are not presented here.

2.3.2. Procedure

In this study participants (henceforth named raters) rated the video clips of participants generated during Part 1. The rating task was hosted on Gorilla Experiment Builder (Anwyl-Irvine, Massonnié, Flitton, Kirkham, & Evershed, 2020), providing judgements of expressivity and attractiveness, how much they liked the participant and how much they wanted to engage in conversation with them. Videos captured in Part 1 were edited to show only the participants (not the confederate) and presented without audio. For each participant, one 10-s clip was taken from the middle of each of the three conditions. Raters rated 66 videos each; one video of each Part 1 participant, randomly selected from the three conditions (FTF, Video Call (self-visible), Video Call (self-hidden)). This was to ensure we were capturing a first impression of the person in the video and to reduce variability in responses due to differences in the videos (the Video Call recordings appear different from the FTF recordings in terms of video quality and position of the camera). Raters watched the 10-s clip once with no questions on the screen, then on the following two screens the video was replayed once at the top of the screen and questions regarding the person in the video were presented on slider scales below the video (all ratings were on a sliding scale from 0 to 100). Raters were reimbursed after successful completion of the survey. All participants provided complete responses and correct responses to attention checks.

2.4. Statistical analysis

Data was prepared and analysed using RStudio, (R version 4.3.1; RStudio build 524) (R Core Team, 2021; RStudio Team, 2020). Full details on R packages used and versions can be found in the supplementary materials. Model comparisons are based on R-squared and AIC values, and ANOVA model comparison tests. Model diagnostics indicated acceptable distribution of residuals, and VIF levels were all below 2.5, which is considered a conservative acceptable level (Johnston, Jones, & Manley, 2018). We used dummy coding (indicator coding) for the categorical variables. For the experimental condition, the FTF condition serves as the reference category. This coding scheme allows us to compare each of the other conditions (Video Call (self-hidden) and Video Call (self-visible)) to the FTF condition. For age group, the reference category is younger adults; for gender the reference category is female.

2.4.1. Part 1

To examine the differences in expressivity across conditions multilevel linear regression models were computed with condition (three levels: FTF, Video Call (self-hidden), Video Call (self-visible)), age group and gender as fixed effects, and participant ID and confederate ID as random effects. The dependent variables were our six facial expressivity measures: rate, duration, repertoire, combination repertoire, corrected repertoire and diversity score. Full models are available in the supplemental materials. The expressivity composite score cannot be compared across conditions as it is a composite of z scores calculated per condition, which are standardised within each condition group (thus the mean value in condition is zero). The random effects allow us to control for individual level and confederate level variation in facial expressivity measures. However, for three of the six dependent variables (repertoire, corrected repertoire, and diversity score) models did not converge when the confederate level was included, so confederate level was omitted from further analyses for only these three models. Models were compared against a corresponding null model – which was comprised of age group, gender and the random effects structure. To account for multiple comparisons, p-values from model comparison tests were adjusted using the Holm method.

The analyses for social outcomes across conditions included: multilevel linear regression models with participant liking score as the dependant variable, condition (with three levels) as the fixed effect, and participant ID and confederate ID as the random effects. This was then compared to a null model consisting of solely the random effects. Correspondingly a multilevel linear regression with confederate liking score as the dependant variable, condition (with three levels), age group and gender of the participants as the fixed effects and participant ID and confederate ID as the random effects. This model was compared to a null model consisting of age group, gender, and the random effects.

2.4.2. Exploratory Analysis

Given the marked individual differences in expressivity and liking in the initial analyses, we were interested in whether individuals might react differentially to different conditions in terms of expressivity in relation to their personality. As the greatest variation across conditions was found with AU rate and duration, we examined whether personality explained variation in these two measures. Linear regression modelling was applied with the **difference** in AU rate and duration across conditions set as the dependant variables. Personality traits (agreeableness, extraversion, conscientiousness, openness, and emotional stability), age group, and gender, were set as predictors of the difference in expressivity between conditions.

The dependent variables were therefore the difference in rate and duration between: the FTF and Video Call (self-visible) conditions, the FTF and Video Call (self-hidden) conditions, and the Video Call (self-visible) and Video Call (self-hidden) conditions. Six exploratory models were computed, in the result section we present a summary of the findings, however full model results are available in the supplementary materials. F-statistics for the overall model are presented to indicate whether the model is significantly different from the intercept only model (with no predictors).

2.4.3. Part 2

In Part 2, we carried out independent ANOVAs with expressivity, liking, attractiveness and engagement scores (provided by the online raters) as the dependent variables and condition as the predictor. To determine whether the facial expressivity score of Part 1 participants was an independent predictor of rater liking scores a linear regression was carried out with the dependant variable liking rating, and the predictors: experiment condition, facial expressivity score, attractiveness rating, age category and self-reported gender. This full model was compared with a model without facial expressivity score as a predictor to assess its independent impact on the results.

3. Results

3.1. Part 1: social interaction dyads

There were strong correlations between facial expressivity scores in the three conditions (FTF and Video Call (self-visible): $r\,(61) = 0.72$, $p < 0.001$; FTF and Video Call (self-hidden): $r\,(60) = 0.78$, $p < 0.001$; Video Call (self-visible) and Video Call (self-hidden): $r\,(61) = 0.82$, $p < 0.001$). Facial expressivity therefore appears relatively stable across interactions within an individual (see Fig. 2), though there are clear overall individual differences, and in terms of how much an individuals' expressivity varies across conditions.

1 Facial Expressivity measures across conditions

As illustrated in Fig. 3, certain measures of facial expressivity vary more notably across conditions, with individuals displaying high variability across all measures. For instance, the mean AU rate for the FTF condition was higher (M = 115, SD = 46) compared to the Video-Call SH condition (M = 96.2, SD = 39.2) and the Video-Call SV condition (M = 92.9, SD = 39.2). The mean AU rate for all three conditions combined was 101 AUs per minute (SD = 42.5), with a range from 10.2 to 211 AUs per minute. See supplementary material for other measures.

3.1.1. Condition

As can be seen in Table 2, controlling for age group and gender, the addition of condition as a predictor to the regression models improved model fit for rate, duration, corrected repertoire, and combination repertoire. Once a Holm correction was applied to the p-values, the ANOVA model comparisons suggested significant model improvement for rate and combination repertoire, as well as a borderline significant improvement for duration. The change in AIC (ΔAIC = 5) lends support to model improvement for duration once condition is included.

The regression results indicated that several facial expressivity measures were greater in the face-to-face condition (reference category) compared to one or both video call conditions. Rate was higher in FTF compared to Video Call (self-hidden) and Video Call (self-visible) conditions *(*$B = -18.52$, $p < 0.001$*);* $B = -23.21$, $p < 0.001$). Similarly, combination repertoire and corrected repertoire were higher in the FTF than the Video Call (self-hidden) ($B = -13.01$, $p < 0.05$; $B = -0.55$, $p = 0.04$) and Video Call (self-visible) conditions ($B = -19.53$, $p < 0.01$; $B = -0.69$, $p = 0.01$).While duration ($B = -17.78$, $p < 0.05$) was higher in FTF compared to the Video Call (self-visible) condition, but not compared to the (self-hidden) condition.

Post-hoc pairwise contrasts performed with the package '*emmeans*' indicated that none of the expressivity measures were substantially different between the Zoom Call conditions ($p > 0.05$).

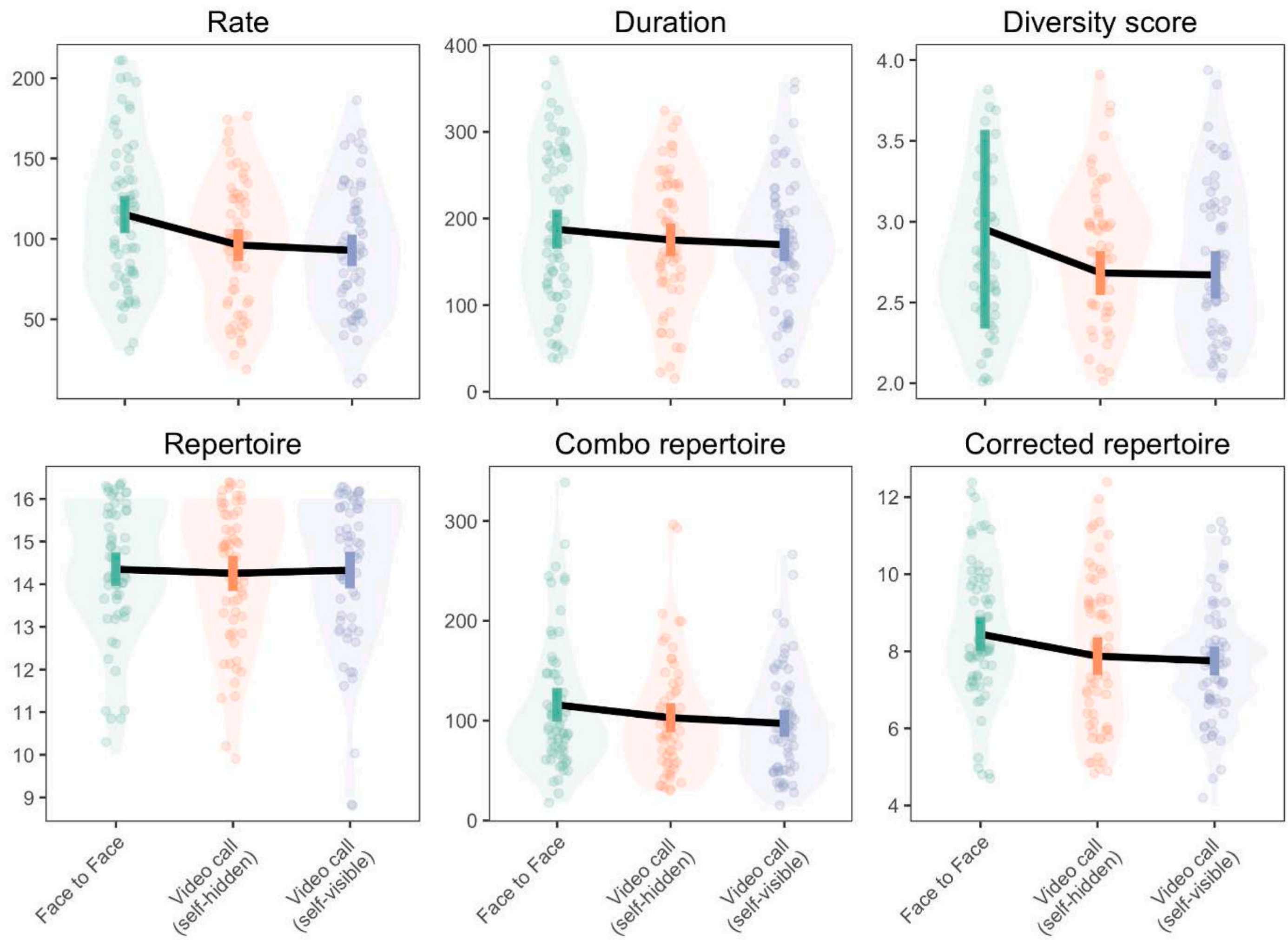

Fig. 3. Expressivity measures across conditions with 95% confidence intervals. *Note.* Each y-axis represents different units: Rate (AUs per minute), Duration (combined percentage of frames that AUs are present – see Table 1), Diversity score (see Table 1 for calculation), Repertoire (number of unique AUs), Combination Repertoire (number of unique combinations of AUs), Corrected Repertoire (number of unique AUs in the first 25 AUs).

Table 2
Results of ANOVA model comparisons between full and null models for each expressivity measure.

Model DV	Null Model		Full Model				Model comparison		
	df	*AIC*	*df*	*AIC*	*R*	*Adj. R^2*	*Chisq*	*p*	*Corrected p*
Rate	6	1836	8	1793	0.13	0.84	47.77	**<0.001**	**<0.001**
Duration	6	2034	8	2029	0.11	0.84	8.70	**0.01**	0.05
Repertoire	5	671	7	675	0.02	0.51	0.17	0.92	0.92
Corrected repertoire	5	735	7	732	0.05	0.31	7.45	**0.02**	0.07
Combination repertoire	6	1990	8	1984	0.04	0.70	10.46	**<0.01**	**0.03**
Diversity score	5	678	7	680	0.02	0.25	1.96	0.38	0.75

Note. Marginal and Conditional R-squared presented. Degrees of freedom differ for repertoire, corrected repertoire and diversity score as confederate level was not included as a random effect for these models.

3.1.1.1. Age group. Controlling for gender and experimental condition, age group independently predicted rate ($B = -29.82$, $p = 0.01$), and duration ($B = -62.85$, $p =<0.01$). Older adults had a lower rate and duration of facial movement than younger adults.

The fixed effects in the models account for between 2 and 13% of the variance in expressivity measures between people. However, once the random effects are included much more of the variance is accounted for. For example, in the case of rate, 84% of the variance is accounted for once participant and confederate levels are included, and much of this is due to participants being similarly expressive across conditions (ICC = 0.81). Overall, facial expressivity is reduced in CMC compared to face-to-face, and this trend is amplified in older compared to younger adults.

3.1.1.2. Smiling (AU12) across conditions. AU12 was the most prevalent action unit used by participants in this study. For each condition AU12 was coded as present for an average of 50% of the total frames in each social interaction [range across participants 0–99% of frames]. Participants produced AU12 an average of 30 times per minute (FTF: M = 31.8, SD = 11.6); Video Call (Self-visible): M = 28.8, SD = 10.8); Video Call (Self-hidden): M = 28.6, SD = 11.4).

Smiling behaviour did not substantially differ across conditions. ANOVA results indicated there was not a significant difference in AU12 rate (F (2,186) = 1.76, $p = 0.18$) nor for AU12 duration (F (2,186) = 0.001, $p = 0.99$) across the three conditions.

2 Social outcomes across conditions

Experimental condition was not a significant predictor of how much the participant liked the confederates (see Table 3). According to the ANOVA model comparison, the addition of the main effect of condition did not significantly improve model fit for the prediction of participant liking scores compared to the null model, χ^2 (2) = 2.69, $p = 0.26$. The change in AIC (ΔAIC) between the two models was <2.

There is some indication that confederates liked male participants less, and liked participants they interacted with in the Video Call (self-visible) less than the participants they interacted with face-to-face, $B = -4.47$, $p = 0.03$. However, the addition of condition did not significantly improve model fit, χ^2 (2) = 4.11, $p = 0.13$. The ΔAIC between the two models was <1. The fixed effects accounted for approximately 4.8% of the variation in confederate liking scores, and less than 1% of the variation in participant liking scores.

Individual differences in how much the participants and confederates liked their interaction partner had a large impact. Most of the variance in liking scores is attributed to the random effects - accounting for 59% of the variance for how much the participants liked confederates and 52% of the variance for how much the confederates liked the participants.

3. Exploratory Analysis: Individual differences and expressivity across conditions

The outcome of the models exploring the difference between conditions for AU rate and AU duration are presented for each condition pair: FTF vs. Video Call (self-visible); FTF vs. Video Call (self-hidden); Video Call (self-visible) vs. Video Call (self-hidden).

3.1.2. FTF vs. video call (self-visible)

The overall model for rate was statistically significant in predicting the difference in expressivity between FTF and video call (self-visible) (F (7, 54) = 2.38, $p = 0.03$, Adjusted $R^2 = 13.7$). Agreeableness was associated with greater expressivity in FTF ($B = 17.93$, $p = 0.02$) and compared to male participants, females had a larger difference in rate between conditions: females were more expressive FTF ($B = -25.38$, $p < 0.01$).

The overall model for duration was statistically significant in predicting the difference in expressivity between the two conditions (F (7, 54) = 2.18, $p = 0.05$, Adjusted $R^2 = 12.0$). Agreeableness was associated with greater expressivity in FTF ($B = 25.49$, $p = 0.04$) and females had a larger difference in expressivity between conditions than males ($B = -44.24$, $p < 0.01$).

3.1.3. FTF vs. video call (self-hidden)

The overall models for rate and duration were statistically significant in predicting the differences between the FTF and Video Call (self-hidden) conditions (F (7, 53) = 3.50, $p < 0.01$, Adjusted $R^2 = 22.6$; F (7, 53) = 2.45, $p = 0.03$, Adjusted $R^2 = 14.4$). Though, in both models only self-reported gender was a significant predictor of the difference in rate ($B = -29.87$, $p < 0.001$) and duration ($B = -25.38$, $p < 0.01$) (see Fig. 4). Females were more expressive FTF, whereas males did not differ as substantially between conditions.

3.1.4. Video call (self-visible) vs. video call (self-hidden)

The model for rate was not statistically significant in predicting the difference between the video call conditions (F (7, 54) = 0.80, $p = .59$, Adjusted $R^2 = -0.02$) and none of the personality variables predicted a difference between video call conditions.

The model for duration was not statistically significant in predicting the difference between the video call conditions (F (7, 54) = 1.20, $p = .32$, Adjusted $R^2 = 0.02$). Only extraversion was a significant predictor of the difference ($B = -16.10$, $p = 0.02$) (Fig. 4).

Overall, these findings suggest that personality traits may play a role in how individuals express themselves in CMC. Agreeable individuals tend to be more expressive FTF, while extraverted individuals tend to be more expressive in the video call condition when they could see their own face. There were also gender differences, as females were more expressive FTF than online, while males were similarly expressive across contexts (see Table 4).

3.2. Part two: independent raters

For each Part 1 participant an average rating score for expressivity, liking, engagement and attractiveness was calculated for each condition, based on the ratings from the raters in Part 2 (see Table 5).

Here, we carried out independent ANOVAs with expressivity, liking, attractiveness and engagement as the dependent variables and condition as the predictor. The ANOVA results suggest that ratings of these characteristics were not significantly different across conditions ($p > 0.05$), further supporting the notion that social outcomes are comparable for in-person and online interactions.

As can be seen in Fig. 5, raters' assessments of expressivity are correlated with how facially expressive the individual was ($r = 0.21$, $p < 0.01$). Rater's assessments of expressivity also correlated with the confederate (the interaction partner's) expressivity ratings from Part 1 ($r = 0.32$, $p < 0.01$).

Yet, importantly, the perception of expressivity (for both raters and confederates) was highly related to how much they liked the individual.

Table 3
Condition as a predictor of Liking Scores: Mixed Effects Model Results.

	Participant liking score			Confederate liking score		
Predictors	B	CI	p	B	CI	p
(Intercept)	82.47	77.54–87.40	**<0.001**	78.02	71.44–84.59	**<0.001**
condition [Video Call (self-hidden)]	−3.24	−7.29–0.81	0.18	−2.89	−7.12–1.34	0.18
condition [Video Call (self-visible)]	−0.86	−4.88–3.17	0.68	−4.23	−8.43–−0.02	**0.05**
Age group [older adults]				−0.15	−7.78–7.47	0.97
Gender [male]				−7.63	−14.87–−0.39	**0.04**
Random Effects						
σ^2	131.71			133.74		
τ_{00}	184.70 $_{\text{ID}}$			108.64 $_{\text{ID}}$		
	8.32 $_{\text{confederate ID}}$			38.85 $_{\text{confederate ID}}$		
ICC	0.59			0.52		
N	8 $_{\text{confederate ID}}$			8 $_{\text{confederate ID}}$		
	64 $_{\text{ID}}$			63 $_{\text{ID}}$		
Observations	190			179		
Marginal R^2/Conditional R^2	0.006/0.597			0.048/0.547		

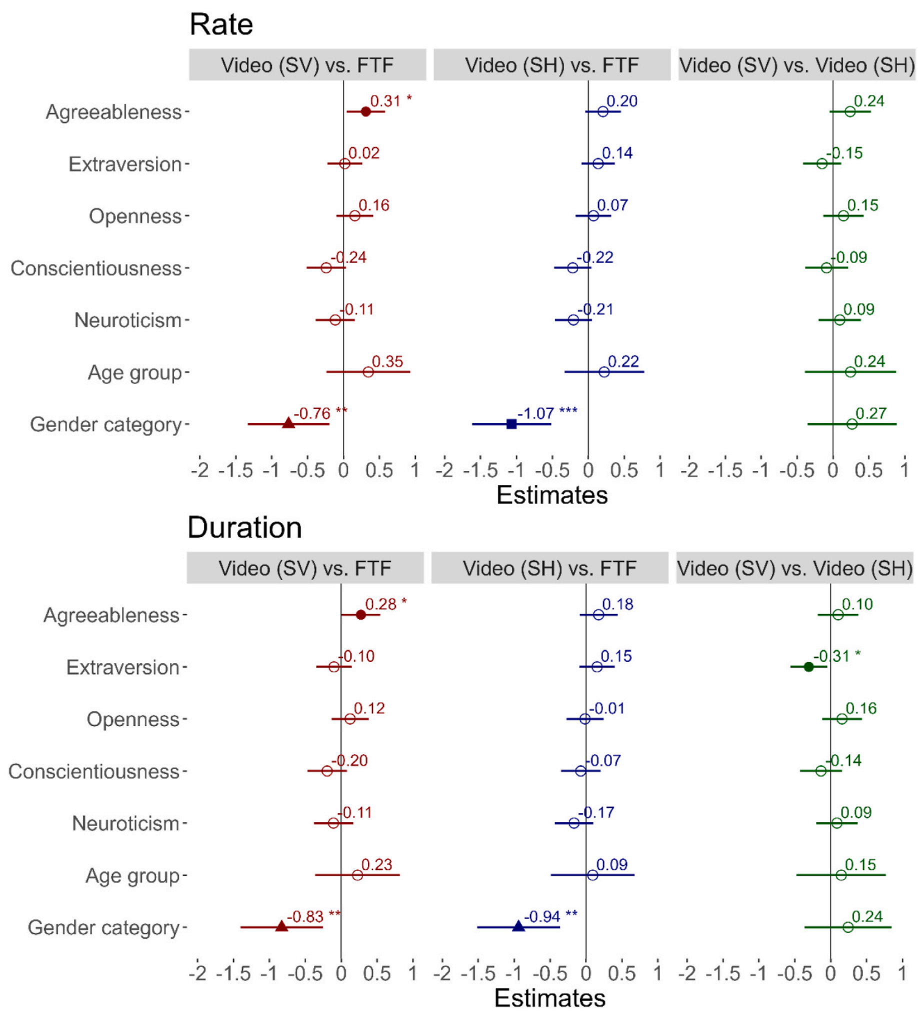

Fig. 4. Standardised beta coefficient for predictors of the difference scores across conditions. *Note.* Video (SV) = Video Call (self-visible), Video (SH) = Video Call (self-hidden). Reference groups: Age group (older adults); Gender category (males).

Table 4
Mean Rate and Duration in each condition by Gender.

Condition	Gender	Rate **Mean (SD)**	Duration **Mean (SD)**
Face-to-face	*Male*	106 (46.6)	157 (87.2)
	Female	119 (46.1)	199 (89.1)
Zoom (Self-Visible)	*Male*	104 (34.2	172 (70.4)
	Female	89.9 (40.4)	171 (78.3)
Zoom (Self-Hidden)	*Male*	108 (37.1)	180 (61.0)
	Female	93.5 (38.9)	176 (79.1)

For confederates the perception of expressivity was associated with liking to a greater degree ($r = 0.55$) than the actual expressivity of the person they had recently interacted with ($r = .21$). Overall, these findings indicate that people are using facial expressivity to assess liking, but that other factors must play a role in constructing a first impression of general expressivity. Attractiveness is likely to play a role in assessments of liking and expressivity. Here, we found a strong relationship between liking and attractiveness ($r = 0.66$). Raters are also more likely to assess people they consider more attractive as more expressive ($r = 0.29$).

Due to the high correlation between attractiveness and liking, we carried out exploratory analyses to determine the factors that were associated with the online raters liking assessments. A linear regression was carried out with the dependant variable liking rating, and the predictors: experiment condition, facial expressivity score, attractiveness

Table 5
Average Ratings for Expressivity, Liking, Attractiveness and Engagement for Part one participants across conditions.

Ratings		FTF (N = 66)	Video Call (self-hidden) (N = 66)	Video Call (self-visible) (N = 66)	Overall (N = 198)
Expressivity	Mean (SD)	57.0 (10.8)	54.1 (13.6)	51.7 (13.0)	54.2 (12.6)
	Min - Max	34.1–77.3	29.8–81.5	27.5–82.3	27.5–82.3
Liking	Mean (SD)	59.2 (6.18)	59.0 (6.42)	57.7 (6.23)	58.6 (6.28)
	Min - Max	44.9–72.1	45.9–71.4	43.2–71.7	43.2–72.1
Attractiveness	Mean (SD)	52.3 (10.4)	52.6 (11.1)	51.6 (9.78)	52.2 (10.4)
	Min - Max	30.0–78.3	28.8–73.7	31.5–70.7	28.8–78.3
Engagement	Mean (SD)	56.1 (7.59)	54.1 (7.37)	52.8 (7.38)	54.3 (7.54)
	Min - Max	38.1–71.3	40.0–70.3	36.3–69.1	36.3–71.3

Note. Missing data: FTF (3: 4.5%), Video Call (self-hidden) (3: 4.5%), Video Call (self-visible) (2: 3%) is due to missingness of video data from Part one.

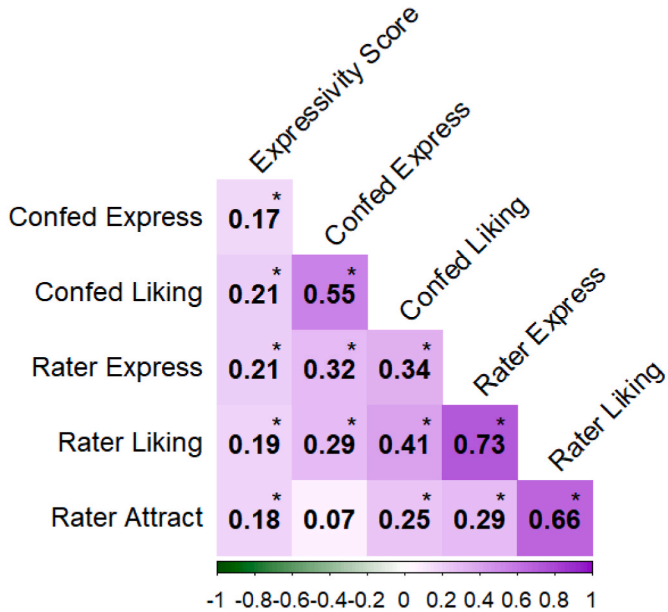

Fig. 5. Correlations between facial expressivity, confederate and rater assessments. *Note.* Confed Express = confederates' assessment of participant expressivity. Rater Express = raters' assessment of participant expressivity. *represent significant correlations at $p < 0.05$.

rating, age category and self-reported gender.

Regression results suggest that age, attractiveness rating and objective facial expressivity predicted liking (see Table 6). To enable comparison of estimates, standardised beta coefficients are presented here. Being an older adult was the most predictive of being more well liked, followed by a higher attractiveness rating, followed by facial expressivity. Liking ratings were likely to be lower in the online call where people could see themselves, but experimental condition was not a significant predictor of liking nor was gender.

Furthermore, model fit was improved by the retention of facial expressivity score as a predictor, $F(1, 182) = 4.63$, $p = .03$, as indicated by a higher adjusted R^2 (53.5 vs. 52.5) and a lower AIC value (1102 vs. 1105). The results suggest that attractiveness rating has a substantial impact on liking ratings, but controlling for attractiveness rating, subjective facial expressivity remains positively associated with liking rating.

4. Discussion

Computer mediated communication (CMC) had a significant impact on overall facial behaviour; participants were generally more expressive in the in-person interactions compared to video call interactions. Our findings fit with a growing body of literature suggesting that online video communication, although similar and closely related, does not fully reflect in-person social interaction in terms of subtle differences in behaviour (Lieberman & Schroeder, 2020) and underlying neural responses (e.g., Zhao, Zhang, Noah, Tiede, & Hirsch, 2023). There were, however, only minor differences between video call conditions, where participants could either see or not see their own face via self-view. And, regardless of group-level differences across conditions, individuals exhibited similarity in how expressive they were in their social interactions across conditions, supporting the notion that facial expressivity is a stable individual trait (Waller et al., 2022). Facial expressivity appears to be highly individual – people differ vastly in how expressive they are in social interactions, and some individuals behave more similarly across conditions than others. Social outcomes did not differ as a function of CMC, as people were liked as much and reported liking their social partners similarly in all three conditions. Independent raters also liked participants to a similar degree in all three conditions. This consistency in social outcomes suggests that individual differences play a pivotal role in shaping social judgments. Despite the discernible differences in expressivity across conditions, the substantial variability in liking assessments is primarily attributed to differences between individuals. In essence, while contextual factors may influence social interactions to some extent, individual characteristics remain the dominant force in shaping perceptions and evaluations in social settings. The findings of this study suggest that similar to personality traits (e.g., Zuroff, Sadikaj, Kelly, & Leybman, 2016), facial expressivity operates within a framework of state-trait duality (Steyer, Schmitt, & Eid, 1999). Within this framework individuals would demonstrate variability in their facial expressions based on situational contexts, yet the variance across repeated assessments tend to converge around a central mean. This is important for the consideration of how facial expressivity is treated as a characteristic, and perhaps evidence for its inclusion as an individual trait.

A number of individual differences were associated with changes in expressivity across conditions, demonstrating that people can respond differently to CMC despite the overall group level differences. Females were more facially expressive in person compared to online, whereas males did not differ in facial expressivity across conditions. Many studies have shown sex differences in social cognition (e.g., Proverbio, 2017) which could lead females to be more sensitive to the setting and potentially explain this finding. Older adults exhibited less facial expressivity in video calls (as well as less facial expressivity overall) which could reflect a lower usage of CMC and comfort in these settings in comparison to younger adults (e.g., Hope, Schwaba, & Piper, 2014). Although we did not account for the regularity of the use of computer mediated communication, we would expect there to be age related factors that influence how regularly our participants would usually engage with others online. By happenstance our sample divided into age groupings, however, the older adults group was smaller and the proportion of females was greater in the older adults group. Future work could explore age related differences with a larger sample of older adults and extend participants selection to adolescents who tend to interact online even more often than adults (Valkenburg & Peter, 2009).

In this study, the exploratory analyses indicated that some personality types responded differently to CMC. The personality traits agreeableness and extraversion were associated with differences in expressivity across conditions. People who are more agreeable were more expressive when they interacted face-to-face in comparison to both online conditions. While people who are more extraverted were more expressive in the online condition where they could see their own face (self-view). Our findings on agreeableness are reflective of research on how personality types elect to learn online and in-person. For example, in a study of students choosing whether to take their higher education course online or face-to-face, students scoring higher in agreeableness were more likely to choose to take their classes face-to-face (Chesser, Murrah, & Forbes, 2020). So it may be that agreeable people prefer to

Table 6
Regression results for predictors of Liking Rating.

	Rater Liking Rating			
Predictors	B	std. Beta	CI	p
(Intercept)	30.28	−0.14	25.12–35.44	**<0.001**
Condition [Video Call (self-hidden)]	−0.45	−0.07	−1.96–1.06	0.56
Condition [Video Call (self-visible)]	−1.14	−0.18	−2.64–0.36	0.14
Expressivity score	0.95	0.11	0.08–1.83	**0.03**
Attractiveness rating	0.53	0.87	0.44–0.61	**<0.001**
Age category [older]	5.96	0.95	3.94–7.97	**<0.001**
Observations	190			
R^2/R^2 adjusted	0.552/0.535			

interact in-person over online, and therefore exhibit more facial behaviour. Extraverts' facial expressivity, in contrast, appears to be uniquely impacted by the ability to self-monitor. In the personality literature, there is some evidence to link extraversion and trait self-monitoring. Snyder (1974) defines self-monitoring as the degree to which individuals observe, adapt, and regulate their behaviour based on how others perceive it. As a result, individuals characterised as high self-monitors are driven to participate in behaviours that enhance their acceptance or elevate their status (Gangestad & Snyder, 2000). These descriptors have a similarity to descriptions of extraverts –who tend to be outgoing, enthusiastic, and sociable with others (McCrae & John, 1992). Researchers have proposed that both extraversion and self-monitoring are associated with a shared aspiration for status and engagement in status-seeking behaviour (Barrick et al., 2005). While we are not specifically studying trait self-monitoring, in the self-visible condition the ability to self-monitor is available to participants. As extraverts tend to adapt their behaviour in social situations, it is unsurprising that this ability to self-monitor may influence the behaviour of extraverts over and above other personality types. Furthermore, extraversion and agreeableness have also been associated with the formation and maintenance of social ties (Harris & Vazire, 2016; Rollings, Micheletta, Van Laar, & Waller, 2022). The exploratory analyses expose a limitation of looking solely at group level data, as at the individual level the differences that we see in facial behaviour in relation to communication contexts may be obscured. Consequently, conducting replication studies investigating the interplay between personality traits, facial behaviour, and communication contexts would yield valuable insights and further our understanding in this area.

Facial expressivity was correlated with liking, and predicted how well-liked the individual was by their social partners in Part 1, and by independent raters in Part 2, indicating that facial expressivity is likely to contribute to the formation of first impressions by both interaction partners and external viewers. An interesting finding here is that perception of expressivity is associated with liking to a greater degree than objective facial expressivity. So, while the facial behaviours we measured contribute to the impression of general expressivity there must be other factors that contribute to this impression, not measured in this study. For example, vocal expressivity and other non-verbal behaviours are likely to contribute to impressions of how expressive someone is. Studies suggest that social impressions are formed based on vocal cues even from brief utterances in a foreign language (Baus, McAleer, Marcoux, Belin, & Costa, 2019). Furthermore, some speakers can modulate their voices during interactions depending on their social goals, and this ability to modulate one's vocalisations varies between people (Belyk, Waters, Kanber, Miquel, & McGettigan, 2022). These individual differences in vocal expression could certainly have informed impressions made by the interaction partners (although not the raters as the videos they viewed were muted). Other nonverbal behaviours such as nodding of the head can also impact evaluations of likeability and approachability (Osugi & Kawahara, 2018) and could have contributed to perceptions of expressivity and liking for partners and independent raters in this study.

We asked independent raters to judge the attractiveness of participants from Part 1; as well as provide assessments of their expressivity and how much they liked them. Attractiveness ratings correlated with raters liking judgements and with the raters' assessments of an individual expressivity. This finding aligns with the psychological phenomenon known as the "halo effect." The halo effect refers to the cognitive bias where people tend to assume that individuals with one positive trait, such as physical attractiveness, possess other positive qualities, even if those qualities are unrelated (Dion, Berscheid, & Walster, 1972; Thorndike, 1920). In this context, the halo effect could explain why individuals perceived as more attractive were not only liked more but also rated as more expressive (which may also point towards expressivity being considered a positive quality). However, even controlling for perception of attractiveness, facial expressivity was still predictive of assessments of liking, suggesting that these variables have independent influence on first impressions. It is also important to note that in the online follow up study raters observed video footage of participants from Part 1 during a social interaction where they are moving, talking, and expressing, whereas much research on attractiveness is carried out with still images (Batres & Shiramizu, 2023;Lucker, Beane & Helmreich, 1981). So, the assessments of attractiveness in this study are affected by facial expressions as well as facial appearance.

Our findings may be valuable to educators who are intending to operate in a fully online or blended format. Despite some overall differences in facial behaviour across conditions, first impressions and social outcomes were similar, supporting research showing that educational attainment is similar in online formats to in-person learning (Stevens et al., 2021). Our results also lend support to video call platforms such as Zoom and Microsoft Teams, or social media apps such as Facebook Messenger or WhatsApp, as social interactions that occur in these online spaces can facilitate social affiliation. Continual advances in CMC technology such as improved video and sound quality, and cameras able to track faces as they move, may reduce some of the behavioural differences we found between online and in-person interactions. Facial behaviour is more often studied in the context of expression perception rather than expression production, perhaps due to a historical focus on the universality of facial expressions (Darwin, 1872; Ekman & Friesen, 1971), that has more recently been challenged (Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019; Kavanagh, Whitehouse, & Waller, 2024) or due to the labour-intensive aspects of studying facial movement. As we found comparable first impressions and social outcomes across contexts, we propose that the more efficient and accessible method of the online study of facial expression is a valid proxy for face-to-face research, and that the use of automated software for behavioural coding can greatly speed up the process for this type of work.

4.1. Limitations and future directions

As much as possible, we attempted in this study to create an environment where we could record genuine interactions. However, for logistical reasons we used confederates as the interaction partners. The confederates in this study were both male and female, but we did not match interaction partners based on gender, or any other characteristic, and so we are unable to test the impact that same-sex versus opposite-sex pairings may have on the expressivity of the participants or the liking assessments. We acknowledge that confederates are not a perfect proxy for real-world social interaction partners, as their behaviour may differ from typical social interaction. However, an interaction with a confederate does have high ecological validity because it is still an interaction between two people. The unscripted nature of the interactions also fosters a dynamic spontaneous exchange that reflects genuine social dynamics. The alignment in assessments of expressivity and liking between confederates and independent raters serves as a testament to the credibility and reliability of our findings. Other research using confederates have found similar agreement between confederate and independent raters liking of participants (Kavanagh, Whitehouse, & Waller, 2024). Here, confederates were not blind to the social interaction condition they were in, but they were assigned to a balanced number of each interaction condition and interacted with each participant once. The interaction discussion content, which will differ between dyads, has not been analysed, it is possible that liking and expressivity is affected by what was discussed. Future research could be carried out with genuine participant dyads online.

Eye contact has been shown to have an impact on physiological arousal and facial behaviour, with similar effects on these reactions in both live and video presentation of faces (Hietanen, Peltola, & Hietanen, 2020). In the present study eye contact and the perception of having received direct eye contact will differ between the face-to-face and video call conditions, because in the video calls there is a mismatch between where a person looks on the screen and where the camera is positioned.

Eye-tracking measures could provide more information on the role of gaze direction in social interactions and a more robust indicator of the frequency of self-monitoring in the contexts where one's own face is visible. In this study viewing distance (from screen or interaction partner) was not strictly controlled, though the lab layout remained consistent in Part 1. Research suggests that as distance increases perception of faces can change. For example, in the field of eyewitness testimony, findings indicate that face recognition reduces as distance increases (Lampinen, Erickson, Moore, & Hittson, 2014). And experimental research has shown that viewing distance can impact perception of video quality (Amirpour, Schatz, Timmerer, & Ghanbari, 2021) and perception of certain facial features (Smith & Schyns, 2009) possibly depending on the adaptive benefit of being able to see certain facial signals from a distance (i.e., fear signals in the presence of a threat). In the current study we chose not to use apparatus such as a chinrest to control viewing distance, in favour of a more naturalistic experience, however, future studies could investigate the role of viewing distance and angle. Another factor we have not examined here, but which could be a good avenue for future research, is the role of synchrony and reciprocal exchange of facial expressions between interacting partners. There is some evidence that people spontaneously mimic the facial expressions they observe (Sato & Yoshikawa, 2007) and blocking this process can inhibit accurate recognition of emotions from facial expressions (Oberman, Winkielman, & Ramachandran, 2007). During social interaction, both mimickers and mimickees report feeling more bonded and experiencing a smoother interaction (Stel & Vonk, 2010). Therefore, understanding how CMC interacts with these processes is important.

In this study we did not collect information on the ethnicity or cultural background of the participants or confederates, but future work could explore this avenue. In the emotion literature, there is ongoing debate about the universality of emotional expressions across cultures (see Jack, Garrod, Yu, & Schyns, 2012), and the extent to which facial expressions reflect felt emotions (see Barrett et al., 2019). Cultural differences between collectivist and individualist societies may influence facial behaviour (McDuff, Girard, & Kaliouby, 2017) or facial expression perception (Matsumoto et al., 2002; Tsai et al., 2019). This influence could be mediated by display rules, which vary across cultures in terms of emotion expression (Matsumoto, Takeuchi, Andayani, Kouznetsova, & Krupp, 1998). These cultural differences in production and perception of facial behaviour may interact with the effects of CMC. Likewise, the ethnicity of the interaction pairs may affect how participants behave or perceive others. Possibly due to within-group bias for positive trait attribution (Sofer et al., 2017) and face recognition, although within-group biases are modulated by other factors such as motivation and experience (Hugenberg, Wilson, See, & Young, 2013). More research on facial behaviour during social interactions, outside of the confines of expression of emotion, is required more generally, and across different cultures. This will help us understand the role of individual differences and how they interact with facial behaviour both in-person and via CMC. In the field of facial anatomy, dissection work has also shown that facial musculature has marked individual variability: some people have muscles that others do not, and there can be differences in structure and symmetry (Waller, Cray, & Burrows, 2008), which could also interact with CMC in some way.

5. Summary and conclusion

Overall, these findings suggest that CMC does have an impact on overall facial expressivity, but that these differences are nuanced and related to individual differences (age, gender and personality). Importantly, first impressions and social outcomes did not differ as a function of CMC. Regardless of the communication conditions, being more facially expressive was associated with greater liking by social partners and by independent observers. In essence, while situational factors may influence social interactions to some extent, the unique characteristics of individuals largely shape how they are perceived and evaluated. The present findings provide a positive message to a world that is continually increasing its capacity and use of computer mediated communication.

CRediT authorship contribution statement

Jasmine Rollings: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Eithne Kavanagh:** Writing – review & editing, Project administration, Data curation, Conceptualization. **Alisa Balabanova:** Writing – review & editing, Investigation, Conceptualization. **Olivia Keane:** Writing – review & editing, Investigation, Conceptualization. **Bridget M. Waller:** Writing – review & editing, Supervision, Resources, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data and code isavailable on the OSF: https://osf.io/g5xyn/.

Acknowledgements

We thank the European Research Council for funding this research (Horizon 2020 Consolidator Grant FACEDIFF to BW, grant number 864694).

We would like to express our gratitude to Dr Jamie Whitehouse for his feedback and assistance in creating certain figures in this manuscript. Additionally, we extend our sincere appreciation to the research assistants who contributed to the data collection for this project: Barbara Devaney, Natalia Ptaszynska, Sundara Kashyap Vadapalli, and Harry McCann.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chb.2024.108391.

References

Achterhof, R., Kirtley, O. J., Schneider, M., Hagemann, N., Hermans, K. S. F. M., Hiekkaranta, A. P., et al. (2022). Adolescents' real-time social and affective experiences of online and face-to-face interactions. *Computers in Human Behavior, 129*, Article 107159. https://doi.org/10.1016/j.chb.2021.107159

Amirpour, H., Schatz, R., Timmerer, C., & Ghanbari, M. (2021). On the impact of viewing distance on perceived video quality. In *2021 international conference on visual communications and image processing (VCIP)* (pp. 1–5). IEEE. https://doi.org/10.1109/VCIP53242.2021.9675431.

Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods, 52*(1), 388–407. https://doi.org/10.3758/s13428-019-01237-x

Barrett, L. F., Adolphs, R., Marsella, S., Martinez, A. M., & Pollak, S. D. (2019). Emotional expressions reconsidered: Challenges to inferring emotion from human facial movements. *Psychological Science in the Public Interest, 20*(1), 1–68. https://doi.org/10.1177/1529100619832930

Barrick, M. R., Parks, L., & Mount, M. K. (2005). Self-monitoring as a moderator of the relationships between personality traits and performance. *Personnel Psychology, 58*(3), 745–767. https://doi.org/10.1111/j.1744-6570.2005.00716.x

Batres, C., & Shiramizu, V. (2023). Examining the "attractiveness halo effect" across cultures. *Current Psychology, 42*(29), 25515–25519. https://doi.org/10.1007/s12144-022-03575-0

Baus, C., McAleer, P., Marcoux, K., Belin, P., & Costa, A. (2019). Forming social impressions from voices in native and foreign languages. *Scientific Reports, 9*(1), Article 1. https://doi.org/10.1038/s41598-018-36518-6

Belyk, M., Waters, S., Kanber, E., Miquel, M. E., & McGettigan, C. (2022). Individual differences in vocal size exaggeration. *Scientific Reports, 12*(1), Article 1. https://doi.org/10.1038/s41598-022-05170-6

Benitez-Quiroz, C., Srinivasan, R., & Martinez, A. M. (2016). Emotionet: An accurate, real-time algorithm for the automatic annotation of a million facial expressions in the wild. In *Proceedings of the IEEE conference on computer vision and pattern recognition* (pp. 5562–5570). https://doi.org/10.1109/CVPR.2016.600

Brüne, M., Abdel-Hamid, M., Sonntag, C., Lehmkämper, C., & Langdon, R. (2009). Linking social cognition with social interaction: Non-verbal expressivity, social competence and 'mentalising' in patients with schizophrenia spectrum disorders. *Behavioral and Brain Functions, 5*(1), 1–10. https://doi.org/10.1186/1744-9081-5-6/TABLES/3

Brunet, P. M., & Schmidt, L. A. (2007). Is shyness context specific? Relation between shyness and online self-disclosure with and without a live webcam in young adults. *Journal of Research in Personality, 41*(4), 938–945. https://doi.org/10.1016/j.jrp.2006.09.001

Cañigueral, R., Ward, J. A., & Hamilton, A. F. de C. (2021). Effects of being watched on eye gaze and facial displays of typical and autistic individuals during conversation. *Autism, 25*(1), 210–226. https://doi.org/10.1177/1362361320951691

Carlbring, P., Andersson, G., Cuijpers, P., Riper, H., & Hedman-Lagerlöf, E. (2018). Internet-based vs. face-to-face cognitive behavior therapy for psychiatric and somatic disorders: An updated systematic review and meta-analysis. *Cognitive Behaviour Therapy, 47*(1), 1–18. https://doi.org/10.1080/16506073.2017.1401115

Chesser, S., Murrah, W., & Forbes, S. A. (2020). Impact of personality on choice of instructional delivery and students' performance. *American Journal of Distance Education, 34*(3), 211–223. https://doi.org/10.1080/08923647.2019.1705116

Crivelli, C., & Fridlund, A. J. (2018). Facial displays are tools for social influence. *Trends in Cognitive Sciences, 22*(5), 388–399. https://doi.org/10.1016/j.tics.2018.02.006

Cuenca-Martínez, F., Zapardiel-Sánchez, E., Carrasco-González, E., La Touche, R., & Suso-Martí, L. (2020). Assessing anxiety, depression and quality of life in patients with peripheral facial palsy: A systematic review. *PeerJ, 8*, Article e10449. https://doi.org/10.7717/peerj.10449

Darwin, C. (1872). *The expression of the emotions in man and animals*. John Murray.

Dion, K., Berscheid, E., & Walster, E. (1972). What is beautiful is good. *Journal of Personality and Social Psychology, 24*(3), 285–290. https://doi.org/10.1037/h0033731

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology, 17*(2), 124–129. https://doi.org/10.1037/h0030377

Ekman, P., & Friesen, W. (1978). *Facial action coding system: A technique for the measurement of facial movement*. CA: Consulting Psychologists Press.

Ekman, P., Friesen, W., & Hager, J. (2002). The facial action coding system. *Research Nexus*.

Fridlund, A. J. (1994). *Human facial expression: An evolutionary view*. Academic Press. https://psycnet.apa.org/record/1994-98273-000.

Girard, J. M., Cohn, J. F., Jeni, L. A., Sayette, M. A., & De la Torre, F. (2015). Spontaneous facial expression in unscripted social interactions can be measured automatically. *Behavior Research Methods, 47*(4), 1136–1147. https://doi.org/10.3758/s13428-014-0536-1

Gosling, S. D., Rentfrow, P. J., & Swann, W. B. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality, 37*(6), 504–528. https://doi.org/10.1016/S0092-6566(03)00046-1

Harrigan, J., Rosenthal, R., & Scherer, K. (Eds.). (2008). *New handbook of methods in nonverbal behavior research*. Oxford University Press.

Harris, K., & Vazire, S. (2016). On friendship development and the Big Five personality traits. *Social and Personality Psychology Compass, 10*(11), 647–667. https://doi.org/10.1111/spc3.12287

Hietanen, J. O., Peltola, M. J., & Hietanen, J. K. (2020). Psychophysiological responses to eye contact in a live interaction and in video call. *Psychophysiology, 57*(6), Article e13587. https://doi.org/10.1111/psyp.13587

Hope, A., Schwaba, T., & Piper, A. M. (2014). Understanding digital and material social communications for older adults. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 3903–3912). https://doi.org/10.1145/2556288.2557133

Hugenberg, K., Wilson, J. P., See, P. E., & Young, S. G. (2013). Towards a synthetic model of own group biases in face memory. *Visual Cognition, 21*(9–10), 1392–1417. https://doi.org/10.1080/13506285.2013.821429

iMotions Biometric Research Platform (SW Version) (iMotions A/S). (2001). [Computer software].

Jack, R. E., Garrod, O. G. B., Yu, H., & Schyns, P. G. (2012). Facial expressions of emotion are not culturally universal. *Proceedings of the National Academy of Sciences, 109*(19), 7241–7244. https://doi.org/10.1073/pnas.1200155109

Jack, R. E., & Schyns, P. G. (2017). Toward a social psychophysics of face communication. *Annual Review of Psychology, 68*, 269–297. https://doi.org/10.1146/ANNUREV-PSYCH-010416-044242

John, O. P., & Srivastava, S. (1999). The Big Five trait taxonomy: History, measurement, and theoretical perspectives. In L. A. Pervin, & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 102–138). Guilford Press.

Johnston, R., Jones, K., & Manley, D. (2018). Confounding and collinearity in regression analysis: a cautionary tale and an alternative procedure, illustrated by studies of British voting behaviour. *Quality & quantity, 52*, 1957–1976. https://doi.org/10.1007/s11135-017-0584-6.

Kavanagh, E., Whitehouse, J., & Waller, B. M. (2024). Being facially expressive is socially advantageous. *Sci Rep, 14*, 12798. https://doi.org/10.1038/s41598-024-62902-6.

Keltner, D. (1996). Facial expressions of emotion and personality. *Handbook of emotion, adult development, and aging*, 385–401.

Lampinen, J. M., Erickson, W. B., Moore, K. N., & Hittson, T. B. (2014). Effects of distance on face recognition: Implications for eyewitness identification. *Psychonomic Bulletin & Review, 21*(6), 1489–1494. https://doi.org/10.3758/s13423-014-0641-2

Lieberman, A., & Schroeder, J. (2020). Two social lives: How differences between online and offline interaction influence social outcomes. *Current Opinion in Psychology, 31*, 16–21. https://doi.org/10.1016/j.copsyc.2019.06.022

Lucker, G. W., Beane, W. E., & Helmreich, R. L. (1981). The strength of the halo effect in physical attractiveness research. *Journal of Psychology, 107*(1), 69–75.

Matsumoto, D., Consolacion, T., Yamada, H., Suzuki, R., Franklin, B., Paul, S., et al. (2002). American-Japanese cultural differences in judgments of emotional expressions of different intensities. *Cognition & Emotion, 16*(6), 721–747. https://doi.org/10.1080/02699930143000608

Matsumoto, D., Takeuchi, S., Andayani, S., Kouznetsova, N., & Krupp, D. (1998). The contribution of individualism vs. Collectivism to cross-national differences in display rules. *Asian Journal of Social Psychology, 1*, 147–165. https://doi.org/10.1111/1467-839X.00010

McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of Personality, 60*(2), 175–215. https://doi.org/10.1111/j.1467-6494.1992.tb00970.x

McDuff, D., Girard, J. M., & Kaliouby, R. (2017). Large-scale observational evidence of cross-cultural differences in facial behavior. *Journal of Nonverbal Behaviour, 41*, 1–19. https://doi.org/10.1007/s10919-016-0244-x

Miller, M. K., Mandryk, R. L., Birk, M. V., Depping, A. E., & Patel, T. (2017). Through the looking glass: The effects of feedback on self-awareness and conversational behaviour during video chat. In *Proceedings of the 2017 CHI conference on human factors in computing systems* (pp. 5271–5283). https://doi.org/10.1145/3025453.3025548

Okdie, B. M., Guadagno, R. E., Bernieri, F. J., Geers, A. L., & Mclarney-Vesotski, A. R. (2011). Getting to know you: Face-to-face versus online interactions. *Computers in Human Behavior, 27*(1), 153–159. https://doi.org/10.1016/j.chb.2010.07.017

Osugi, T., & Kawahara, J. I. (2018). Effects of head nodding and shaking motions on perceptions of likeability and approachability. *Perception, 47*(1), 16–29. https://doi.org/10.1177/0301006617733209

Proverbio, A. M. (2017). Sex differences in social cognition: The case of face processing. *Journal of Neuroscience Research, 95*(1–2), 222–234. https://doi.org/10.1002/jnr.23817

Revelle, W. R. (2017). *psych: Procedures for Personality and*. Psychological Research.

R Core Team. (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.r-project.org/.

Rollings, J., Micheletta, J., Van Laar, D., & Waller, B. M. (2022). Personality traits predict social network size in older adults. *Personality and Social Psychology Bulletin*. , Article 01461672221078664. https://doi.org/10.1177/01461672221078664

RStudio Team. (2020). *RStudio: Integrated development environment for R. (1.3.1056) [mac OS]*. RStudio. http://www.rstudio.com/.

Satchell, L., Morris, P., Mills, C., O'Reilly, L., Marshman, P., & Akehurst, L. (2017). Evidence of Big five and aggressive personalities in gait biomechanics. *Journal of Nonverbal Behaviour, 41*(1), 35–44. https://doi.org/10.1007/s10919-016-0240-1

Sato, W., & Yoshikawa, S. (2007). Spontaneous facial mimicry in response to dynamic facial expressions. *Cognition, 104*(1), 1–18. https://doi.org/10.1016/j.cognition.2006.05.001.

Sayette, M. A., Cohn, J. F., Wertz, J. M., Perrott, M. A., & Parrott, D. J. (2001). A psychometric evaluation of the facial action coding system for assessing spontaneous expression. *Journal of Nonverbal Behavior, 25*, 167–185. https://doi.org/10.1023/A:1010671109788

Scheider, L., Liebal, K., Oña, L., Burrows, A., & Waller, B. (2014). A comparison of facial expression properties in five hylobatid species. *American Journal of Primatology, 76*(7), 618–628. https://doi.org/10.1002/ajp.22255

Schmitt, D. P., Allik, J., McCrae, R. R., & Benet-Martínez, V. (2007). The geographic distribution of Big five personality traits: Patterns and profiles of human self-description across 56 nations. *Journal of Cross-Cultural Psychology, 38*(2), 173–212. https://doi.org/10.1177/0022022106297299

Shin, S. Y., Ulusoy, E., Earle, K., Bente, G., & Van Der Heide, B. (2022). The effects of self-viewing in video chat during interpersonal work conversations. *Journal of Computer-Mediated Communication, 28*. https://doi.org/10.1093/jcmc/zmac028

Smith, F. W., & Schyns, P. G. (2009). Smile through your fear and sadness: Transmitting and identifying facial expression signals over a range of viewing distances. *Psychological Science, 20*(10), 1202–1208. https://doi.org/10.1111/j.1467-9280.2009.02427.x

Soto, C. J., & John, O. P. (2009). Ten facet scales for the Big Five Inventory: Convergence with NEO PI-R facets, self-peer agreement, and discriminant validity. *Journal of Research in Personality, 43*(1), 84–90. https://doi.org/10.1016/j.jrp.2008.10.002

Spradlin, A., Cuttler, C., Bunce, J. P., & Carrier, L. M. (2019). #Connected: Facebook may facilitate face-to-face relationships for introverts. *Psychology of Popular Media Culture, 8*(1), 34–40. https://doi.org/10.1037/ppm0000162

Sprecher, S. (2014). Initial interactions online-text, online-audio, online-video, or face-to-face: Effects of modality on liking, closeness, and other interpersonal outcomes. *Computers in Human Behavior, 31*, 190–197. https://doi.org/10.1016/j.chb.2013.10.029

Stagg, S. D., Slavny, R., Hand, C., Cardoso, A., & Smith, P. (2014). Does facial expressivity count? How typically developing children respond initially to children with autism. *Autism, 18*(6), 704–711. https://doi.org/10.1177/1362361313492392

Stel, M., & Vonk, R. (2010). Mimicry in social interaction: Benefits for mimickers, mimickees, and their interaction. *British Journal of Psychology, 101*, 311–323. https://doi.org/10.1348/000712609X465424

Stevens, G. J., Bienz, T., Wali, N., Condie, J., & Schismenos, S. (2021). Online university education is the new normal: But is face-to-face better? *Interactive Technology and Smart Education, 18*(3), 278–297. https://doi.org/10.1108/ITSE-08-2020-0181

Steyer, R., Schmitt, M., & Eid, M. (1999). Latent state–trait theory and research in personality and individual differences. *European Journal of Personality, 13*(5), 389–408. https://doi.org/10.1002/(SICI)1099-0984(199909/10)13:5<389::AID-PER361>3.0.CO;2

Tacikowski, P., & Nowicka, A. (2010). Allocation of attention to self-name and self-face: An ERP study. *Biological Psychology, 84*(2), 318–324. https://doi.org/10.1016/j.biopsycho.2010.03.009

Tackman, A. M., Baranski, E. N., Danvers, A. F., Sbarra, D. A., Raison, C. L., Moseley, S. A., et al. (2020). 'Personality in its natural habitat' revisited: A pooled, multi–sample examination of the relationships between the Big five personality traits and daily behaviour and language use. *European Journal of Personality, 34*(5), 753–776. https://doi.org/10.1002/per.2283

Thorndike, E. L. (1920). A constant error in psychological ratings. *Journal of Applied Psychology, 4*(1), 25–29. https://doi.org/10.1037/h0071663

Tsai, J. L., Blevins, E., Bencharit, L. Z., Chim, L., Fung, H. H., & Yeung, D. Y. (2019). Cultural variation in social judgments of smiles: The role of ideal affect. *Journal of personality and social psychology, 116*(6), 966–988. https://doi.org/10.1037/pspp0000192

Valkenburg, P. M., & Peter, J. (2009). Social consequences of the internet for adolescents: A decade of research. *Current Directions in Psychological Science, 18*(1), 1–5. https://doi.org/10.1111/j.1467-8721.2009.01595.x

Waller, B. M., Cray, J. J., & Burrows, A. M. (2008). Selection for universal facial emotion. *Emotion, 8*(3), 435–439. https://doi.org/10.1037/1528-3542.8.3.435. Washington, D.C.

Waller, B. M., Kavanagh, E., Micheletta, J., Clark, P. R., & Whitehouse, J. (2022). The face is central to primate multicomponent signals. *International Journal of Primatology*, 1–17. https://doi.org/10.1007/s10764-021-00260-0

Waller, B. M., Whitehouse, J., & Micheletta, J. (2017). Rethinking primate facial expression: A predictive framework. *Neuroscience & Biobehavioral Reviews, 82*, 13–21. https://doi.org/10.1016/j.neubiorev.2016.09.005.

Weller, S. (2017). Using internet video calls in qualitative (longitudinal) interviews: Some implications for rapport. *International Journal of Social Research Methodology, 20*(6), 613–625. https://doi.org/10.1080/13645579.2016.1269505

Zhao, N., Zhang, X., Noah, J. A., Tiede, M., & Hirsch, J. (2023). Separable processes for live "i n-person" and live "zoom-like" faces. *Imaging Neuroscience*. https://doi.org/10.1162/imag_a_00027

Zuroff, D. C., Sadikaj, G., Kelly, A. C., & Leybman, M. J. (2016). Conceptualizing and measuring self-criticism as both a personality trait and a personality state. *Journal of Personality Assessment, 98*(1), 14–21. https://doi.org/10.1080/00223891.2015.1044604

Oberman, L. M., Winkielman, P., & Ramachandran, V. S. (2007). Face to face: Blocking facial mimicry can selectively impair recognition of emotional expressions. *Social Neuroscience, 2*(3–4), 167–178. https://doi.org/10.1080/17470910701391943.