Computers in Human Behavior Reports 19 (2025) 100750

Contents lists available at ScienceDirect

Computers in Human Behavior Reports

journal homepage: www.sciencedirect.com/journal/computers-in-human-behavior-reports

No evidence for generational differences in the conventionalisation of face emojis

Vera Kempe [a], Limor Raviv [b,c,*]

[a] Abertay University, Dundee, UK
[b] Max Planck Institute of Psycholinguistics, Nijmegen, the Netherlands
[c] Radboud University, Nijmegen, the Netherlands

ARTICLE INFO

Keywords:
Emoji
Age cohort effects
Semiotics

ABSTRACT

Despite strong popular beliefs that older users misunderstand emojis, empirical evidence is equivocal. Here we propose that different generations of users may vary in the degree of intra-generational agreement on emoji meanings (i.e., how much people from the same generation agree on what an emoji means). Inspired by research in cultural evolution demonstrating a positive association between social network size and the conventionalisation of signs, we hypothesised that younger users would show stronger agreement on emoji meanings because they tend to be embedded in larger online social networks than older users. We examined generational differences in intra-generational agreement on emoji interpretations, taking into account variability arising from different emoji renderings across platforms. In a pre-registered online study, 394 respondents from the culturally defined generations of GenZ (n = 152, age 13–24 years), Millennials (n = 149, age 25–40 years), and GenX/BabyBoomers (n = 93, age 41–76 years) produced three words to describe the meanings of 24 target face emojis and 10 popular filler emojis. Frequentist and Bayesian analyses showed no generational differences in intra-generational response entropy and in the probability of selecting the most frequent meaning within one's generation. Exploratory analysis further showed that the most commonly provided emoji interpretations did not differ across generations, despite generational differences in social media usage patterns. Together, these findings suggest that different generations not only interpret face emojis in similar ways, but also show similar intra-generational agreement on emoji meanings, consistent with the idea that, after a decade of use, face emojis have become a widely conventionalised semiotic system accessible to digital media users regardless of age.

1. Introduction

Since their introduction in 2011, emojis have gained widespread use as a way to enhance digital communication by signalling emotions and modulating communicative intent of written text (Kaye, Malone, & Wall, 2017). At their core, these graphic symbols were designed to capture a range of facial expressions - and have since expanded to include renderings of objects, animals, symbols, flags and more. Given the ubiquity of this novel semiotic system – i.e., already in 2015 emojis were estimated to be used by 92 % of the online population (Emoji Consumer Science Team, 2015) – the question of consistency in emoji interpretation across different groups of users has gained considerable prominence, partially because of its importance to various applied domains, e.g. for using face emojis as a convenient tool in marketing communication and customer surveys (Kaye et al., 2017; Luangrath et al., 2017; Jaeger et al., 2018). However, despite their widespread use, there allegedly appears to be considerable disagreement on what emojis mean (Miller et al., 2016, 2017; Częstochowska et al., 2022).

One factor that has been repeatedly suggested to impact emoji interpretation and emoji use is age, with anecdotal evidence and newspaper headlines frequently highlighting differences in how younger and older digital media users understand emojis. (e.g. Capobianco, 2022; Waldman, 2016; Weckler, 2023). For example, one popular belief is that younger people prefer conventionalised non-iconic and non-literal interpretations of emojis, such as the innuendo connotations associated with the eggplant (🍆) and the peach (🍑) emojis (Weissman, 2019), which are less likely to be familiar to older people (Waldman, 2016). But despite the popular assumption that older people do not understand emojis in the same way as younger people do, research paints a mixed pattern of results, both with respect to the interpretation

* Corresponding author.
E-mail address: Limor.Raviv@mpi.nl (L. Raviv).

https://doi.org/10.1016/j.chbr.2025.100750
Received 23 December 2024; Received in revised form 27 June 2025; Accepted 11 July 2025
Available online 21 July 2025

of emojis in general, and of face emojis in particular. On the one hand, older adults were found to be less confident in their understanding of the pragmatic functions of emojis accompanying texts - they more frequently interpreted the function of these emojis as relating to their literal meaning, whereas younger adults interpreted them as softening or modifying the tone of a message in conventionalised ways (Herring & Dainas, 2020). Older adults also tended to provide higher arousal ratings for some negatively valenced face emojis compared to younger people (Kutsuzawa et al., 2022). When asked to identify the meanings of face emojis on lists of emotion labels, older adults were less accurate than younger adults in identifying surprised, fearful, sad, and angry emojis (rendered across four platforms), but were not less accurate for disgusted and happy face emojis (Chen et al., 2024). The selective lower accuracy of face emoji interpretations was attributed to age-related decline in the capacity to process facial expressions of emotion (Chen et al., 2024) – a deficit that is well attested in the facial emotion processing literature (Hayes et al., 2020). On the other hand, several studies failed to find age differences. For example, Boutet et al. (2024) found no age differences in the accuracy of identifying meanings for most of the angry, happy, sad and surprised face emojis used in their study, with the 'wide eyes'-surprise emoji being the only exception. Although older adults tended to exhibit reduced technology acceptance, reflecting reduced ease of use and lower perceived usefulness of this technological innovation (Venkatesh & Bala, 2008), this did not affect the accuracy of their emoji interpretations - a null-finding that was echoed in a few other studies as well (Gallud et al., 2018; Jaeger et al., 2018).

When investigating age effects, it is important to distinguish effects of age, e.g. maturational effects or effects of cognitive decline, from cohort effects, i.e. generational effects related to factors shared by members of the same age group (for a detailed treatment see Rohrer, 2025). One possibility is that age differences in emoji interpretation reflect generational differences in the frequency of emoji use. However, evidence for this is also mixed. On the one hand, some surveys and real-world user data found that older adults (>50 years of age in some studies, but more often >60 or 65 years of age) tend to use emoticons and emojis less frequently (An et al., 2018; Boutet et al., 2024; Emogi Research Team, 2016; Herring & Dainas, 2020; Koch et al., 2022; Wu et al., 2024) - a finding that was recently corroborated by a 2023 US YouGov poll conducted with 8458 adults (YouGov, 2023). Similarly, it has also been suggested that the emoji repertoire of older people is more restricted (An et al., 2018; Boutet et al., 2024). On the other hand, some studies have failed to find age differences in emoji use frequency (Fullwood et al., 2013; Gallud et al., 2018), suggesting that age differences in emoji use may not be a good explanation for age differences in emoji interpretation.

The suggestion that there may be differences in emoji interpretation between user groups, including age cohorts, may seem surprising given the high degree of iconicity of these signs. After all, the heart-shaped emoji (❤️) depicts a heart and the lip-shaped emoji (💋) depicts lips. Yet the dominant interpretation of the former emoji is 'love' and of the latter 'kiss' (see Table 1), going beyond the immediate iconic meaning towards more conventionalised cultural associations. Indeed, evidence from reaction time (Weissman et al., 2023) and eye-tracking experiments (Barach et al., 2021) show that emojis are treated as conventionalised signs rather than images. Even face emojis are not treated in an iconic fashion and are not processed in a similar way as emotion expressions in real faces. Evidence for this comes from the finding that the perceived meanings of face emojis can vary depending on certain feature differences that do not necessarily correspond to the facial action units underlying emotion expression in human faces (Fricke et al., 2024). To illustrate this point, consider the grinning face with smiling eyes (😄) and the beaming face with smiling eyes (😁) emojis. According to well-established face analysis techniques used with humans (Ekman & Friesen, 1978), these two emojis engage the exact same facial action units, since the presence or absence of the lower row of teeth is not considered an action unit in smiling faces. Therefore, both emojis should in theory be associated with the same positive emotion. However, when having to match them to texts, participants did not employ them interchangeably; instead, they associated the former more with 'amusement' and the latter more with 'intense joy'. If emojis, including face emojis, are treated as lexicalised signs in this manner, then their meaning has likely been subject to a process of conventionalisation.

Crucially, treating emojis as a conventionalised semiotic system offers a potentially different explanation for the age-related differences reported in some studies. Here, we suggest that age differences in emoji interpretation may in fact reflect cohort differences in the degree of emoji *conventionalisation* (i.e., how much people within an age cohort agree or disagree on the meaning of a given emoji, i.e. *intra-cohort* agreement), rather than reflecting differences in the specific meanings assigned to emojis by different age cohorts (i.e. whether one age cohort collectively interprets an emoji in the same or in different ways than another age cohort, i.e. *inter-cohort* agreement). Studies have already pointed out that there can be considerable variation in agreement on emoji interpretations in general, but this has been studied predominantly with respect to agreement differences between various emojis (Miller et al., 2016, 2017; Częstochowska et al., 2022), but not between age cohorts. Notably, if one age cohort shows less intra-cohort agreement on what a specific emoji means, then this would inevitably result in greater inter-cohort differences in accuracy when the provided interpretation is compared to a predefined meaning - as most studies on age differences do. In other words, what we are suggesting here is that differences in the degree of agreement on emoji interpretations *within* age-cohorts could, in part, explain the observed interpretation differences *between* age cohorts. In particular, we hypothesise that, when compared to older adults, younger adults show greater agreement amongst themselves on what emojis mean (i.e., greater intra-cohort agreement).

Why should younger cohorts exhibit more conventionalisation of the meanings of emojis compared to older cohorts? Although emojis were introduced as a novel semiotic system to all users of online media at the same time (about a decade ago), it is likely that their use and conventionalisation have been affected by different social and demographic factors associated with age. Specifically, one factor that may affect agreement on the meaning of an emoji is the size of the online social network of a user group. Multiple experimental semiotics studies, computational models, and cross-linguistic work on language typology and change suggest that social network size plays an important role in how signal systems in different modalities diffuse, evolve and acquire meaning. On the one hand, small and dense social networks are associated with faster diffusion of signs within the group, more conformity, less variability, and more alignment between members, preserving and amplifying existing linguistic norms and resisting external pressures to change (Bahlmann, 2014; Fagyal et al., 2010; Gong et al., 2012; Granovetter, 1983; Ke et al., 2008; Milroy & Milroy, 1985; Shaw-Ching Liu et al., 2005; Trudgill, 2002, 2009). At the same time, the high degree of familiarity between members of small and dense communities can in fact reduce the pressure to establish *new* conventions in the early stages of sign formation, and thus preserve variation across individuals. This is supported by computational models and data from real-world emerging sign languages, which shows that signals created by smaller social networks are in fact less conventionalised than in larger social networks (Thompson, Raviv & Kirby; 2019; Mudd et al., 2022; de Vos, 2011; Meir et al., 2012; Meir & Sandler, 2019; Tkachman & Hudson Kam, 2020; Lutzenberger et al., 2023). Moreover, people in smaller social networks have more malleable linguistic representations, while people in larger social networks tend to have more stable linguistic representations (Lev-Ari, 2018). This is because representations entrenched over instances of use with many communication partners are less likely to shift when novel variants are encountered. Taken together, this research on the link between social network size and the spread of linguistic variants suggests that as new signals emojis should be more conventionalised in larger online social networks.

Table 1
10 filler and 24 target facial emojis rendered in Apple iOS with descriptions from Emojipedia, and the percent of most frequently provided lemma within all responses for each generation (see explanation in Results). Asterisks indicate that the lemma is the root of several word forms. Underline indicates that the most frequent meaning assigned by that generation differs from those of the other generations.

Emoji with Emojipedia description	GenZ		Millennials		GenX/Boomers	
	Meaning	%	Meaning	%	Meaning	%
	filler emojis					
1 Loudly Crying Face	cry*	23.8	cry*	20.5	cry*	15.1
2 Winking Face	wink	29.5	wink	25.9	wink	21.7
3 Smiling Face with Sunglasses	cool	50.0	cool	46.4	cool	27.3
4 Thinking Face	think	31.1	think	27.0	think	24.5
5 Red Heart	love	53.4	love	54.0	love	58.0
6 Kiss Mark	kiss	43.1	kiss	55.0	kiss	49.7
7 Flexed Biceps	strong	27.3	strong	23.8	strong	27.2
8 Fire	fire	26.0	fire	24.4	hot	26.6
9 Smiling Face w/Smiling Eyes	happy*	34.6	happy*	36.9	happy*	39.7
10 OK Hand	ok	25.0	ok	34.2	ok	35.0
	target face emojis					
11 Flushed Face	embarrass*	22.8	embarrass*	27.9	surpris*	18.7
12 Sleepy Face	sad*	15.0	sad*	13.4	sad*	30.9
13 Grimacing Face	awkward*	13.2	awkward*	9.1	nervous	7.0
14 Disappointed Face	sad*	33.6	sad*	35.8	sad*	46.8
15 Pouting Face	angry	33.3	angry	33.9	angry	38.3
16 Weary Face	moan*	4.4	frustrat*	5.9	sad*	8.3
17 Downcast Face with Sweat	sad*	11.2	sad*	13.3	sad*	20.1
18 Sad but Relieved Face	sad*	22.3	sad*	27.5	sad*	35.0
19 Expressionless Face	annoy*	11.4	annoy*	8.5	nothing	5.0
20 Smiling Face with Horns	evil	13.0	evil	11.5	devil*	20.1
21 Kissing Face with Closed Eyes	kiss*	31.4	kiss*	43.4	kiss*	35.9
22 Winking Face with Tongue	silly*	10.3	cheeky*	18.3	cheeky*	10.1
23 Squinting Face with Tongue	silly*	11.5	cheeky*	11.5	cheeky*	9.4
24 Face Without Mouth	speechless	14.3	speechless	12.1	speechless	10.9
25 Astonished Face	shock*	29.3	shock*	33.0	surpris*	25.7
26 Persevering Face	sad*	9.2	frustrat*	9.2	sad*	9.7
27 Face with Steam From Nose	angry	14.3	angry	15.0	angry	13.8
28 Angry Face	angry	28.8	angry	29.1	angry	35.3
29 Tired Face	frustrat*	7.4	frustrat*	7.6	upset	8.5
30 Anxious Face with Sweat	worry*	12.8	worry*	11.2	sad*	10.2
31 Confused Face	disappoint	14.1	unsure	11.3	unsure	9.3

(*continued on next page*)

Table 1 (*continued*)

Emoji with Emojipedia description	GenZ		Millennials		GenX/Boomers	
	Meaning	%	Meaning	%	Meaning	%
	filler emojis					
32 Face with Open Mouth	surpris*	32.1	shock*	31.3	surpris*	24.0
33 Neutral Face	awkward	5.0	neutral	4.6	neutral	12.2
34 Face with Tongue	silly*	11.8	cheeky*	13.5	cheeky*	15.4

Crucially, previous research has found that younger people tend to have larger social networks: cross-sectional (Wrzus et al., 2013; Bruine de Bruin, Parker, & Strough, 2020) and longitudinal (English & Carstensen, 2014) studies suggest that older age is typically associated with a decline in social network size. Such age-related changes in social network size are often associated with normative life events like marriage, job entry, or widowhood (Wrzus et al., 2013). After adolescence, the decline in social network size appears to reflect a tendency to select and maintain predominantly those relationships that elicit positive emotions (English & Carstensen, 2014). There is some evidence that a similar pattern of social network size reduction with age is also emerging online (Pfeil et al., 2009), most notably in patterns of engagement on Facebook (Chang et al., 2015; Yu et al., 2018). Here, older adults' smaller overall online network size and greater number of close rather than distant friends mirror the increased social selectivity observed in their offline social networks. Therefore, given the evidence for diminishing social network size with age and given the fact that emojis were introduced to all age cohorts at the same time, the conventionalisation of emoji meanings (and resulting degree of intra-cohort agreement on their interpretations) should be stronger in younger people. Taken together, this line of work suggests that social network size may contribute to the putative effect of age on emoji interpretation: older individuals with smaller social networks may agree less on the interpretations of emojis, while younger individuals with larger social networks may show more conventionalised interpretations.

1.1. The current study

The aim of the current study is to examine whether there are differences in intra-cohort agreement on emoji interpretations, and whether such differences are linked to online social network size. Method and analyses were pre-registered (https://osf.io/pxnrv/registrations), with deviations from this pre-registration explained in detail in Section S1 of the Supplementary Materials (https://osf.io/pxnrv/). We administered a survey that included free descriptions, limited to three words, of the meaning of 24 face and 10 filler emojis, as well as questions about the frequency of online interactions and the number of interaction partners to ascertain online social network size. We selected face emojis because many of them have been demonstrated to exhibit lower agreement than emojis of foods, animals, objects etc. (Miller et al., 2016), thus leaving room for variability in agreement (although see Weissman et al. [2023] for some face emojis with high agreement, which we did not include into the target set). To capture the degree of intra-cohort agreement, we operationalise age cohorts in terms of culturally acknowledged generations, which are widely considered to share formative cultural, socio-political, and technological experiences. Specifically, we grouped survey respondents into three age groups representing these generations: GenZ (individuals born between 1997 and 2012), Millennials (individuals born between 1981 and 1996), and GenX/Baby Boomers (henceforth: GenX/Boomers which included individuals born between 1946 and 1980 to obtain comparable cohort sizes).

In contrast to most studies on age differences in emoji interpretation, we opted for free responses as opposed to forced choices between, or a ranking of, a set of predetermined interpretations. Research on the recognition of facial expressions of emotions has shown that forced-choice methodologies tend to overestimate the degree of agreement between individuals (DiGirolamo & Russell, 2017; Russell, 1994). Consequently, studies that used free verbal responses for emoji interpretation demonstrated considerable variability in the degree of agreement across emojis (Miller et al., 2016), with agreement on face emoji meanings being quite low (Częstochowska et al., 2022). However, so far free verbal responses have not been used to examine age-related or generational differences in emoji interpretation agreement. By using free verbal responses limited to three words, we were able to compute response entropy per emoji within each cohort. Response entropy is an information-theoretic measure reflecting the spread of the rank-frequency distribution of participants' responses within a group—higher entropy indicates more diverse responses, while lower entropy indicates a narrower spread of responses and, thus, greater intra-generation agreement. We were also able to determine whether participants had provided the interpretation most frequently mentioned by their generation as an additional measure of agreement. We also surveyed patterns of emoji usage and online social network size by asking participants about their frequency of media use, the number of direct online social interactions, their preferred platform, and more. We predicted that participants from GenZ, the youngest participants who comprise the first cohort of 'digital natives', would exhibit larger online social networks as well as greater intra-generational agreement on emoji interpretations, as measured by lower entropy of emoji meanings and a higher likelihood to mention the most frequent interpretation within their generation. We also explored whether there is a difference in social network size and degree of emoji interpretation agreement between Millennials and GenX/Boomers.

2. Method

2.1. Participants

Ethical clearance was granted by the Abertay University Ethics Committee for testing participants from the age of 13 years upwards without parental consent based on the acknowledgement that individuals from this age onward are legally able to sign up to social media sites and messaging apps and will therefore be familiar with emoji usage. Overall, the survey was administered to 595 participants between July 8, 2021 and 16 March 2022.201 participants were excluded because they did not complete the questions on their texting behaviour and social media use (n = 43), did not provide age information (n = 90), did not explicitly provide consent (n = 48), or several of the above combined (n = 20). The remaining 394 participants (249 women, 122 men, 21 non-binary, and 2 with undisclosed gender) ranged in age from 13 to 76 years. We categorised participants aged 13–24 years as GenZ (n = 152, mean age = 18.8 years, s.d. = 3.4 years), participants aged 25–40 years as Millennials (n = 149, mean age = 31.7 years, s.d. = 4.5 years) and participants aged 41–76 years as a combined cohort comprising GenX and Baby Boomers (n = 93, mean age = 53.1 years, s.d. = 8.9

years).

309 (76.4 %) participants listed English as their primary language, and 361 (91.6 %) participants listed English as their preferred language of online communication. Thus, 52 native speakers of German (n = 11), Dutch (n = 8), French (n = 6), Hebrew, Spanish, Polish and Swedish (each n = 4) and another 14 languages used English for online communication. The remaining 33 participants reported using mainly German (n = 5), Hebrew (n = 5), Dutch (n = 4) and other languages (n = 12) for online communication; seven participants did not disclose their language of online communication. At the time of the survey, 59.4 % of participants resided in the UK (n = 234), 15.7 % in the US (n = 62), 3.8 % in the Netherlands (n = 15), 3.0 % in Germany (n = 12), and 2.3 % in Israel (n = 9), with the remaining participants originating from 30 other countries, only seven of which were East Asian countries, resulting in a predominantly Western, English-speaking sample.

2.2. Materials

We selected a total of 34 face emojis, consisting of 24 target emojis and 10 fillers. Specifically, we used 24 face emojis from Release Version 1.0 (2010–2015) as target test items (see Table 1), with frequency ranks of 5 and 6 according to https://home.unicode.org/emoji/emoji-frequency/(for detailed meaning description and affective valence see Appendix 1). The frequency ranks indicate median use across multiple platforms and locales, with each rank corresponding to half of the usage frequency of the preceding rank and range from 0 (highest use) to 17 (lowest use). We chose face emojis without objects such as hearts or a mask to avoid responses being biased by obvious iconicity. For each target emoji, affective valence was coded based on mouth shape and Emojipedia (emojipedia.org) definition, revealing 13 negative, 5 positive, 3 ambiguous, and 3 neutral target face emojis.

In addition, 10 emojis comprising faces and other icons (e.g., red heart, kiss mark) were selected as fillers. These fillers were of higher frequency rank than the target face emojis and had the highest degree of interpretation agreement out of 30 commonly used emojis in a pilot survey with 195 participants. The purpose of these fillers was twofold: first, we wanted to present some items that could be easily described, to reduce participant frustration, sustain motivation, induce a sense of competence, and provide positive feedback on correct interpretation at the end of the survey. Second, given their high frequency and relative transparency, we expected no generational differences in the interpretation of these filler emojis; they served as a sanity check for whether participants from all three generations had indeed engaged well with the task.

A questionnaire was prepared to capture demographic information about gender, age, country of origin, country of residence, primary language, and language used online. The questionnaire also comprised four single-item questions to obtain self-assessments of social media use. Texting frequency was assessed with the question *"On average, how often do you send or receive text messages?"* Frequency of social media use was assessed with the question *"How often do you check or post on social media?"*, aimed to assess both reception and production of social media content. For these two questions, participants were asked to select one of seven response options on an ordinal scale representing increasing intervals between events, structured to follow an approximately logarithmic progression (*never; a few times* per *year; a few times* per *month; a few times* per *week; a few times* per *day; a few times* per *waking hour; all the time*). Frequency of emoji use was assessed with the question *"How often do you use emojis?"*, and the four response options reflect increasing frequency of emoji use in relation to their texting and posting frequency (*in all of my texts/emails/posts; in most of my texts/emails/posts; in some of my texts/emails/posts; never*). Social network size was estimated using the question *"On average, how many people do you exchange messages with regularly, excluding email and broadcasting to followers on twitter, instagram etc?"*, aimed at tapping into an estimate of direct interactions, with an 8-point ordinal response scale, again structured to follow an approximately logarithmic progression (*nobody; just one person; 2–5; 6–20; 21–100; 101–200; 200–1000, more than 1000*). The full text of the questionnaire is provided in Section S2 of the Supplementary Materials at https://osf.io/pxnrv/.

2.3. Procedure

Participants were recruited via social media snowballing, SONA student participant recruitment, and by posting on reddit fora dedicated to survey distribution (e.g. r/SampleSize). The survey was administered using Qualtrics. Participants first viewed a page explaining the study and asking for consent and then completed the questionnaire capturing demographic information and characteristics of social media use as described above. Next, participants proceeded to the 34 emoji-interpretation questions. For each emoji, participants first saw seven of its graphical renderings across the platforms Apple, Google, Samsung, Microsoft, WhatsApp, Facebook, and Twitter (the survey took place before it was rebranded as X in July 2023), and were asked to indicate which of these emoji versions looked most familiar. They were then given a textbox to answer the question 'What does this emoji convey?' with the constraint to not use more than three words. Order of presentation of emojis was randomised across participants. At the end of the survey, participants were asked to rate their enjoyment of the survey on a Likert-scale from 1 to 5 and were given a space to leave comments if they wanted to. To provide a sense of accomplishment at completion, participants were shown their overall accuracy score for the 10 filler emojis, which was based on the most frequent meaning obtained in the pilot survey.

3. Results

We start by checking inter-generational differences in online emoji usage and then analyse generational differences in intra-generational agreement on emoji meanings. We also include exploratory analyses of whether the three generations overall differed in their emoji interpretation and whether platform familiarity had an effect on intra- and inter-generational interpretation agreement. All analyses were conducted with R version 4.4.1. Linear mixed-effect models were conducted using the *lme4* package (v1.1.35.5; Bates et al., 2015) and Bayesian analyses using the *brms* package (v.2.22.0; Bürkner, 2017).

3.1. Online usage

We analysed participants' ordinal responses to the four questions about online usage—texting frequency, frequency of social media checking, number of people sending and posting messages to (our measure of online social network size), and emoji use (see Fig. 1)—using ordinal logistic regression, as the response scales reflect a natural rank order with approximately logarithmic progression, capturing increasing levels of engagement or magnitude without assuming equal intervals. The ordinal logistic regressions were performed using the polr() function from the MASS package in R (Venables & Ripley, 2002), with a fixed effect for Generation (3-level categorical variable: GenZ, Millennials, GenX/Boomers, treatment coded with GenZ as the reference level). Results show that Generation had a significant effect on the estimated number of texts sent on average ('Texts' in Fig. 1), with GenX/Boomers texting less frequently than GenZ ($\beta = -0.67$, $t = -2.77$, $p = .006$). A Tukey post-hoc test indicated that the difference between Millennials and GenX/Boomers was not significant ($p = .38$). Generation also had a significant effect on the frequency of checking social media ('Checks' in Fig. 1), such that compared to GenZ, both Millennials ($\beta = -0.89$, $t = -4.08$, $p < .001$) and GenX/Boomers ($\beta = -0.98$, $t = -4.10$, $p < .001$) checked social media less frequently. A Tukey post-hoc test indicated that the difference between Millennials and GenX/Boomers was not significant ($p = .91$). The effect of Generation was also significant for our estimate of online social network size (i.e., the number of people that

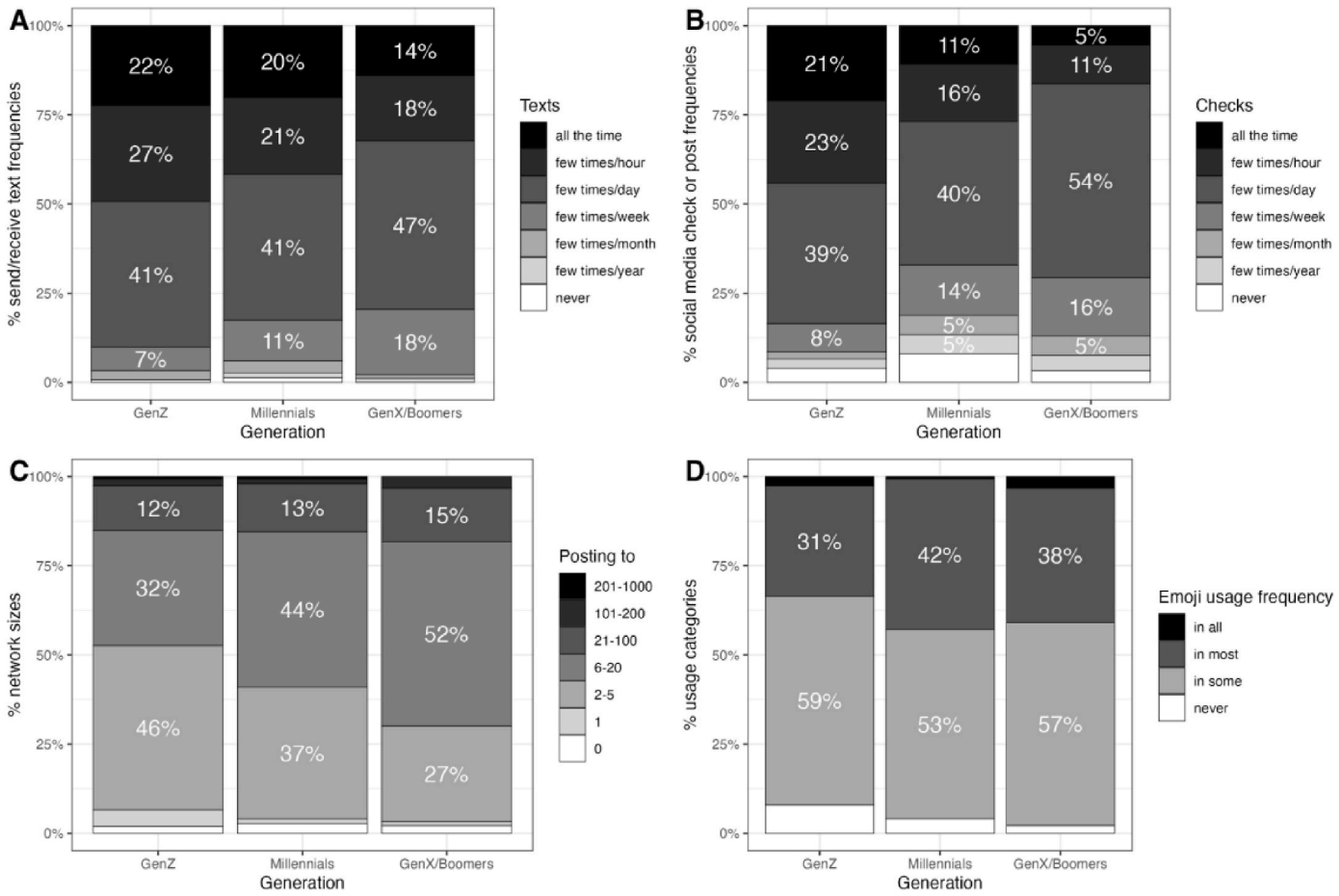

Fig. 1. Percentage of each response category by Generation for estimates of average number of texts (panel A), frequency of checking social media (panel B), number of people sending and posting messages to (panel C), and frequency of emoji usage (panel D). Response categories with a frequency of less than 3 % are not labelled in the graphs.

participants regularly exchange direct messages with; called 'Posted to' in Fig. 1), showing—counter to our expectations—that GenX/Boomers have larger online social networks compared to GenZ ($\beta = 0.73$, $t = 2.95$, $p = .009$). A Tukey post-hoc test indicated that the difference between Millennials and GenX/Boomers was not significant ($p = .31$). Finally, there was no significant effect of Generation on the frequency of emoji usage.

3.2. *Inter-generational differences in intra-generational interpretation agreement*

The degree of intra-generational agreement on emoji interpretations was determined in two ways. First, we computed the response entropy for each of the 34 emoji within a generation, resulting in 102 observations in total, for which we could test the effect of Generation and Emoji type. We opted for analysing participant responses by lemma rather than raw word form so as not to artificially inflate differences in chosen meanings (e.g. "winked", "wink" and "winking" have the same lemma "wink", and thus count here as the same response). Amongst the high-frequency filler items, the 'red heart'-emoji had the highest intra-generational agreement, as indicated by lowest entropy across all generations. The rank-frequency distributions of lemmas for all emojis by generation can be viewed in a supplementary file at https://osf.io/pxnrv/files/osfstorage. The mean entropy per emoji within each generation is shown in Fig. 2.

To test whether there are any inter-generational differences in average intra-generational response entropy per emoji, we fitted a linear model with a full crossing of the treatment-coded fixed effects of Generation (3-level categorical variable: GenZ, Millennials, GenX/Boomers, treatment coded with GenZ as the reference level) and Emoji Type (2-level categorical variable: Filler vs. Target emoji). This model confirmed the effect of Emoji Type ($\beta = 0.20$, $t = 3.00$, $p < .001$), with lower response entropy for the high-frequency filler emojis. Because this frequentist model showed no significant effect of Generation, we performed a Bayesian analysis to establish the strength of the evidence for the null hypothesis (i.e., for the assertion that there are, in fact, no inter-generational differences in intra-generational agreement). We conducted the Bayesian analysis to obtain a more direct assessment of evidence supporting the null hypothesis, which is essential when interpreting non-significant findings that may otherwise reflect a Type II error. To quantify the evidence for the absence of generational differences, we compared two models: a full model (including Generation and its interaction with Emoji Type) and a reduced model (excluding these terms). This comparison via Bayes Factors is necessary because Bayesian inference evaluates how well each model predicts the observed data, allowing us to assess whether including Generation improves explanatory power. A Bayes Factor below 0.0012 indicates strong evidence in favour of the simpler model, supporting the conclusion that Generation

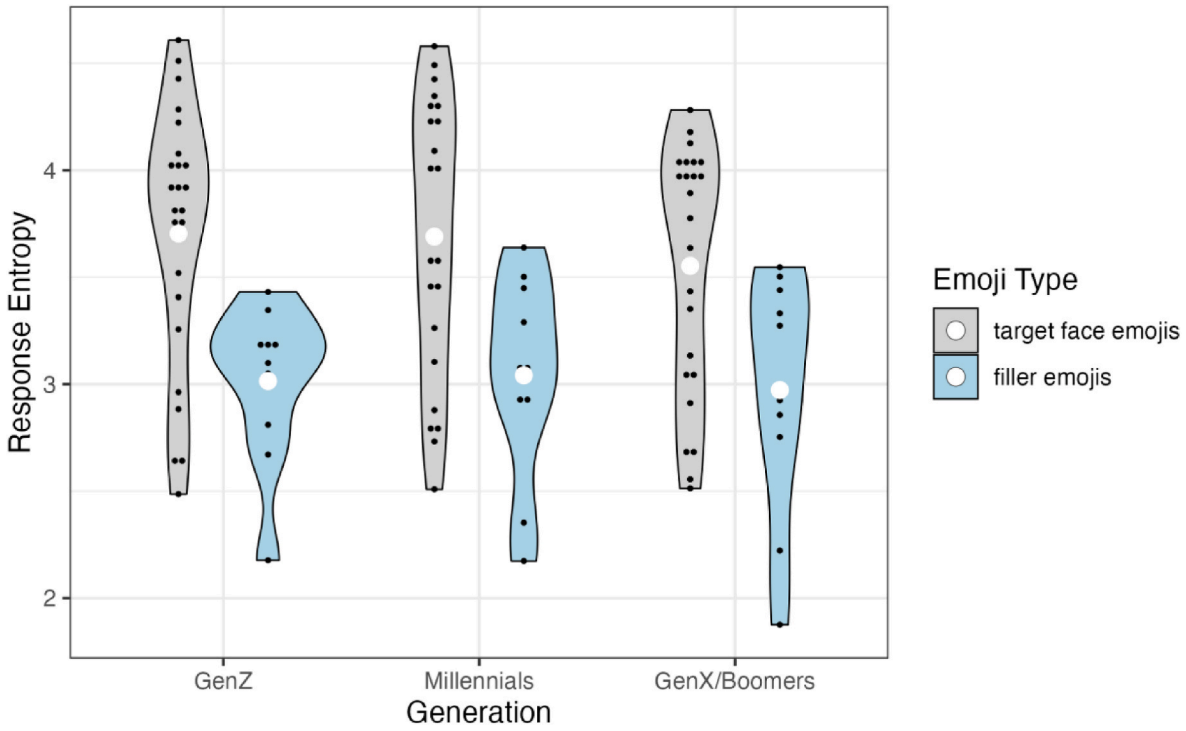

Fig. 2. Response entropy within age cohorts for each emoji as a function of generation and emoji type (target vs filler emojis). White dots indicate the generation mean. Higher entropy suggests lower intra-generational agreement on emoji interpretations.

has no meaningful effect on response entropy.[1]

Because the previous analysis was on emojis as individual observations, it did not allow us to control for participant-specific variables like individual emoji use. We therefore analysed our second measure of intra-generational agreement—whether a participant had included the most frequently provided, i.e. most popular, interpretation in their response for any given emoji. Proportion of agreement on the most frequent interpretation had been used in previous studies to measure interpretation agreement (Weissman et al., 2023). The higher this proportion is, the higher is the intra-generational interpretation agreement. The rationale behind this measure was to establish intra-generational agreement independently from the interpretation that is preferred overall.[2] Thus, even if different generations interpret an emoji in different ways, the degree of agreement within each generation may still be of similar magnitude. Conversely, even if all generations share the most frequently mentioned interpretation, the degree of agreement on it may still differ. We opted to define the most frequently mentioned interpretation by lemma rather than by individual word form to limit spurious variability that can arise from using different word forms with similar meaning, e.g. when describing the Winking Face emoji as either 'wink' or 'winking'. Lemmatisation was performed using the *corpus* and *Snowball* R packages. For each participant and for each emoji, we coded whether the most frequently mentioned lemmas for that emoji within this participants' generation had been produced by the participant or not. As a sanity check on the validity of this agreement measure, we expected the high-frequency filler emojis to show higher agreement in all generations. The proportion of the most frequent lemma mentions per emoji within each generation is shown in Fig. 3.

To control for the potential effect of individual emoji usage on agreement we included Weighted Emoji Usage as a covariate (weighing the response rank of emoji usage by the response rank of texting frequency) in order to account for the fact that a user who used emojis in all their texts but sends texts infrequently may overall use emojis less than someone who includes them only in some of their otherwise frequent texts. We fitted a generalised linear mixed-effect binomial model with fixed effects of Weighted Emoji Usage (continuous, centred) and the full crossing of treatment-coded Generation (3-level categorical variable: GenZ, Millennials, GenX/Boomers, treatment coded with GenZ as the reference level) and Emoji Type (two-level categorical variable: Filler vs. Target emoji) and random slopes of Generation by Emoji and Emoji Type by Participant. The random slope of Weighted Emoji Use by Emoji resulted in failure of the model to converge and was therefore dropped. The revised model yielded a significant effect of Emoji Type ($\beta = 1.51$, $z = 5.04$, $p < .001$), confirming that, in all generations, the proportion of most frequent lemma mentions was higher for the high-frequency iconic filler emojis than for the medium-frequency face emojis. No other effects were significant.[3]

As with the previous analysis, to obtain further evidence for the

[1] To check whether online social network size affected response entropy independently of Generation we also computed response entropy per emoji for participants with small (smaller or equal than 5 people) vs. large (more than 5 people) online social networks and fitted a linear model which confirmed the main effect of Emoji Type ($\beta = 0.18$, $t = 2.92$, $p < .001$) but showed no effect of online social network size ($p = .49$).

[2] This measure differed from the one that had been pre-registered for reasons explained in the Deviation from Pre-Registration Section S1 of the Supplementary Materials (https://osf.io/pxnrv/). Specifically, we opted for analysing the most frequent lemma for each generation instead of the entire sample so that intra-generational agreement would not become skewed by the age distribution.

[3] As per pre-registration, we also fitted the same model to the subsample of 234 UK residents. This analysis corroborated the main effect of Emoji Type ($\beta = 1.41$, $z = 4.54$, $p < .001$). It also yielded an effect of Generation such that agreement was greater for Millennials compared to GenZ ($\beta = 0.32$, $z = 2.12$, $p = .033$). However, this effect was not confirmed by the more conservative Bayesian analysis with weakly informative priors where the credible interval for this effect ranged from −0.00024 to 0.63 and the Bayes Factor was below 0.0003, indicating strong evidence for no differences between generations in proportion of participants who selected the lemma that was most frequent within their generation in the UK residents-only sample.

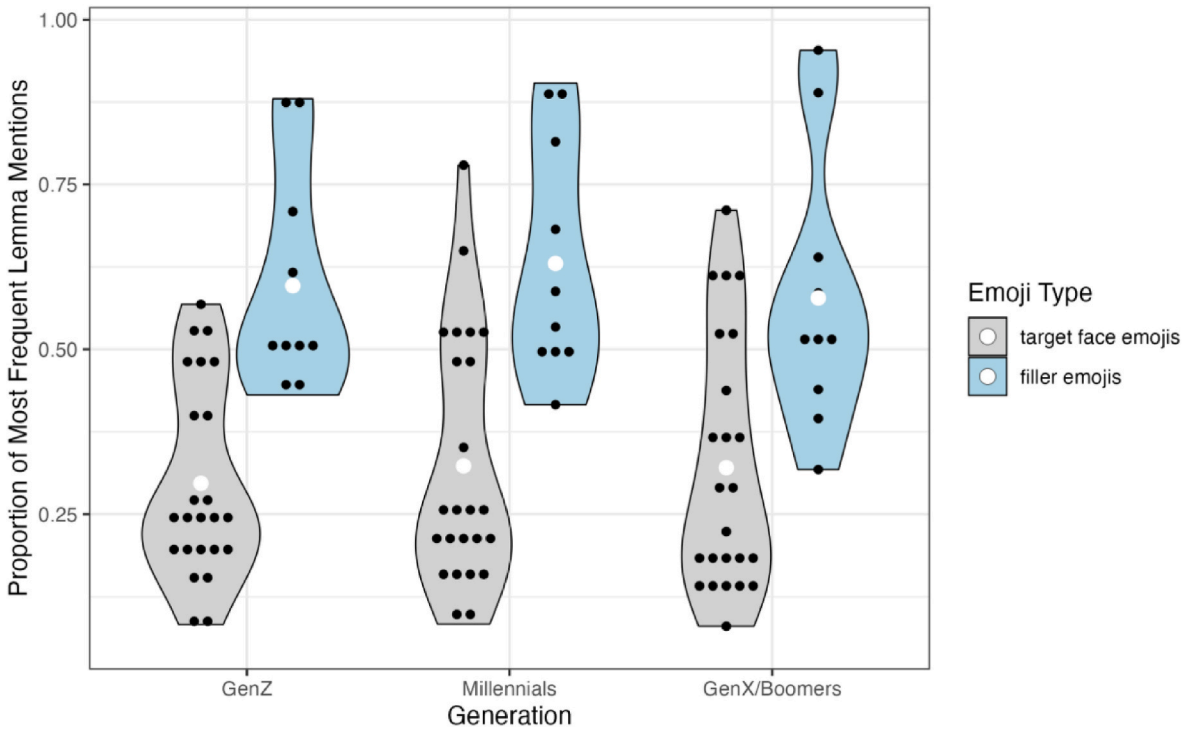

Fig. 3. Proportion of most frequent lemma mentions as a function of Generation and Emoji Type (target vs filler emojis). White dots indicate the generation mean. Higher proportions suggest higher intra-generational agreement on emoji interpretations.

absence of a generational difference, we again compared the marginal likelihoods of two Bayesian models, one with the same fixed and random effects as the frequentist model described above, and one with the fixed effect of Generation and the interaction between Emoji Type and Generation removed, with weakly informative priors for the coefficient estimates. We obtained a Bayes Factor below 0.0001, indicating that there is overwhelming evidence in favour of the null hypothesis, i.e., that there are, in fact, no inter-generational differences in intra-generational agreement as measured by the proportion of mentions of the most frequent lemmas.

3.3. Inter-generational differences in emoji interpretation

Although this study focussed on generational differences in the magnitude of intra-generational interpretation agreement, we also conducted an exploratory analysis to determine whether there were inter-generational differences in how emojis were interpreted, given the interest in this question in the literature. Unlike previous studies (e.g. Boutet et al., 2024; Chen et al., 2024), we did not assume that there exist universally agreed meanings that would allow us to calculate an accuracy measure. Instead, we compared whether the lemma provided most frequently by each generation differed across the three generations. Table 1 lists the most frequently mentioned lemma for each emoji as well as the percent of time within a generation it was included in participants' free verbal responses. As expected, the most frequently provided lemmas were identical across all three generations for nine out of the ten high-frequency filler emojis. For the target face emojis, the most frequently provided lemmas were identical across all three generations for nine (37.5 %) of the 24 emojis. We computed the proportion of agreement for each pairwise comparison of generations for the 24 face emojis and found that for the comparison of GenZ vs. Millennials, the proportion of emojis where the most frequent lemma was identical was 0.67; for GenZ vs GenX/Boomers it was 0.46, and for Millennials vs GenX/Boomers it was 0.58. A 3-sample test for equality of proportions revealed no significant differences in these proportions of agreement on the most frequent lemma, $\chi^2 = 2.15$, df = 2, p = .34. Thus, while there was some disagreement on the most frequently supplied lemmas to describe an emoji's meaning, there was no indication that the oldest generation differed more in their supplied meanings from the two younger ones.

3.4. Platform familiarity

Because of existing evidence showing that different emoji renderings on different platforms can contribute to ambiguity in emoji interpretation (Miller et al., 2017), we also explored whether there are inter- and intra-generational differences in platform familiarity that can contribute to differences in agreement on emoji meanings. Recall that before providing their verbal responses, participants were shown renderings of each emoji across seven different platforms and had to identify the one that looked most familiar to them. The frequency of platform familiarity choices per individual emoji and generation is provided in Table S3 in the Supplementary Materials. For all emojis, Apple iOS was the most familiar platform, with the exception of the sleepy face emoji (😪), for which WhatsApp was the most familiar rendering for GenX/Boomers.

To quantify intra-generational differences in platform familiarity, we computed how often each platform was chosen as the most familiar one by each participant across all emojis, as well as the percentage of how often each platform was chosen overall as the most familiar one per participant. Table 2 shows that these two measures, albeit not identical, mirror each other very closely. After excluding platforms with frequencies below 5, we found that the distributions of the most familiar four platforms (Apple, Facebook, Samsung and WhatsApp) were significantly different across generations ($\chi^2 = 28.29$, df = 6, Cramer's V = 0.20, p < .001). Standardised residuals confirmed that for GenZ, Apple iOS emojis were significantly overrepresented and WhatsApp emojis were significantly underrepresented - suggesting that GenZ was more familiar with Apple emojis and less familiar with WhatsApp emojis, while GenX/Baby Boomers were less familiar with Apple emojis than the other generations.

We also quantified the degree of intra-generational agreement on

Table 2
Percent of respondents within a generation who selected each platform as the most familiar emoji rendering and overall percent of platform choices by generation (in parentheses). Values in boldface indicate that in this generation the platform is significantly overrepresented in the most frequent choices based on standardised residuals exceeding Bonferroni-corrected critical values; underlined values indicate significant underrepresentation of the platform.

	GenZ	Millennials	GenX/Boomers	Total
Apple	**66.2** (65.0)	45.6 (44.4)	38.5 (30.5)	51.9 (46.6)
Facebook	5.3 (5.2)	10.2 (8.5)	7.7 (7.0)	7.7 (6.9)
Google	2.0 (3.8)	5.4 (7.4)	4.4 (10.6)	3.9 (7.3)
Microsoft	0 (0.3)	0 (0.7)	0 (0.2)	0 (0.4)
Samsung	8.6 (9.2)	7.5 (8.9)	15.4 (17.0)	9.8 (11.7)
Twitter	6.0 (5.2)	4.1 (3.7)	3.3 (3.3)	4.6 (4.0)
WhatsApp	11.9 (11.2)	27.2 (26.4)	30.8 (31.3)	22.1 (22.9)

platform familiarity by computing platform entropy within each generation. Low entropy indicates that within a generation participants were more consistent in selecting the same platform-specific rendering as the most familiar one, while high entropy suggests that participants within a generation tended to vary more in their selection of different platform-specific renderings. A linear regression model with Generation and Emoji Type (coded as described above) showed that, compared to GenZ, platform entropy was higher for Millennials ($\beta = 0.25$, $t = 11.03$, $p < .001$) and for GenX/Boomers ($\beta = 0.30$, $t = 13.13$, $p < .001$). The significant main effect of Emoji Type ($\beta = -0.06$, $t = -3.01$, $p < .05$) together with its interaction with Generation ($\beta = 0.09$, $t = 3.21$, $p < .05$) indicates that for GenZ and Millennials – but not for GenX/Boomers – platform entropy was higher for the high-frequency fillers. This means that compared to face emojis, for the high frequency filler emojis there was less consistency in platform familiarity in the two younger generations. Changing the reference category for the fixed effect of Generation to Millennials allowed us to check whether there was a difference between the two older generations in platform entropy, which was indeed the case ($\beta = 0.05$, $t = 2.10$, $p < .05$). These results are depicted in Fig. 4.

We then checked whether these intra-generational differences in platform familiarity may have masked the intra-generational differences in emoji interpretation agreement. It is conceivable that variation in platform familiarity promotes more abstract emoji meanings which could contribute to greater intra-generational interpretation agreement. To check the effect on differences in intra-generational agreement, we rerun the linear model for response entropy as a dependent variable with platform entropy as a covariate. The results confirmed the main effect of Emoji Type ($\beta = 0.60$, $t = 2.79$, $p < .01$) and yielded no other significant effects. This suggests that any differences in participants' familiarity with various emoji renderings and the consistency of their platform choices were unlikely to have affected their agreement on emoji interpretations. In other words, differences in variation of platform familiarity did not affect differences in emoji interpretation agreement across generations.

We also checked potential effects of variation in platform familiarity on inter-generational differences in the predominant meaning. If platform familiarity affects emoji interpretation, as some studies suggest (Miller et al., 2017), then the fact that Apple was the most familiar platform for GenZ while WhatsApp was relatively more familiar to Millennials and GenX/Boomers may have affected inter-generational differences in specific emoji interpretation. To this end, we compared for each pairing of generations whether platform entropy was higher for those emojis where the most frequently provided meanings differed between generations compared to those where they were identical. The three linear models included the factors of Generation (model 1: GenZ vs. Millennials; model 2: Millennials vs. GenX/Boomers; model 3: GenZ vs. GenX/Boomers), respectively, and Most Frequent Lemma (same vs. different). While the models confirmed the effects of Generation on platform entropy already reported above, none of them showed an effect of Most Frequent Lemma nor of the 2-way interaction - suggesting that there is no evidence for an effect of platform entropy. This was confirmed by three corresponding Bayesian models, which all showed that the credible intervals for the interaction straddled 0. Bayes Factors below 0.01 provided strong evidence in favour for the absence of differences in platform entropy for those emoji where there was a

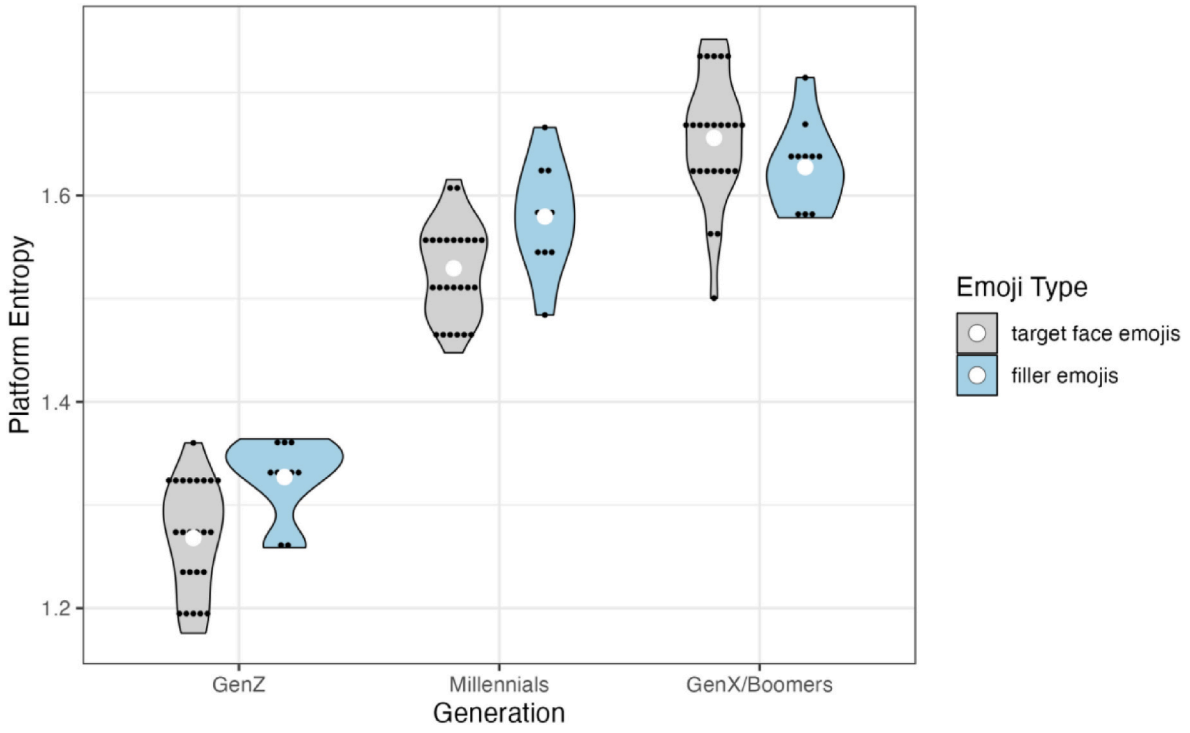

Fig. 4. Platform entropy as a function of Generation and Emoji Type (target vs filler emojis). White dots indicate the generation mean. Higher entropy suggests lower intra-generational agreement on platform usage.

discrepancy in a generation's most frequent meaning compared to those where there was inter-generational agreement. We can therefore be reasonably sure that differences in how much participants within a cohort shared familiarity with a specific emoji rendering did not affect the main results of the study.

4. Discussion

In this study, we tested the idea that putative age differences in emoji interpretation might be due to inter-generational differences in emoji conventionalisation, i.e. the extent to which different generations agree on the meaning of an emoji. This hypothesis was based on two assumptions: (1) that new signs become more conventionalised in larger social networks (Thompson, Raviv, & Kirby, 2019; Mudd et al., 2022; de Vos, 2011; Meir et al., 2012; Meir & Sandler, 2019; Tkachman & Hudson Kam, 2020; Lutzenberger et al., 2023); and (2) that online social network size declines with age (Bruine de Bruin et al., 2020; Wrzus et al., 2013; English & Carstensen, 2014). We operationalised age cohorts as culturally defined generations (GenZ, Millennials, and GenX/Baby Boomers), and hypothesised that GenZ, the first cohort of digital natives, would exhibit greater intra-generational agreement on emoji interpretations compared to older cohorts due to their larger social network size. Yet counter to our hypothesis, when we compared intra-generational agreement on the meanings of 24 medium-frequency face emojis and 10 high-frequency emojis, we found no inter-generational differences in our two measures — response entropy per emoji and the proportion of the most frequently provided lemma for each emoji within a generation. To gain confidence that the three generations showed a similar degree of emoji conventionalisation, we expanded on our pre-registered frequentist models with Bayesian analyses, which showed strong evidence for a lack of generational differences in both measures of emoji agreement.

Moreover, we also explored whether there were inter-generational differences on how emojis were interpreted. For some emojis we found inter-generational differences in the most frequently mentioned lemma (see Table 1), yet there was no evidence that the oldest participants (GenX/Baby Boomers) deviated more from the two younger generations nor that the youngest generation (GenZ) deviated more from the two older generations. Notably, the generational differences in platform familiarity (with GenZ being more consistent in recognising Apple iOS emojis as most familiar) did not affect generational differences in intra-generational agreement, nor what interpretation was most frequently provided by each generation. These null results are in line with several other studies that also failed to observe age differences in emoji interpretation (Boutet et al., 2024; Gallud et al., 2018; Jaeger et al., 2018) suggesting that at the time of testing (i.e., in 2022), the often-assumed generational differences in emoji interpretation may no longer be supported empirically. Furthermore, unlike previous studies (Miller et al., 2017), emoji interpretations did not seem to be affected by their different renderings across platforms.

Not only did we not find the expected inter-generational differences in emoji conventionalisation, but we also did not find evidence for the main premise of this assumption, namely, that GenZ would have larger online social networks, which, in turn, might support greater emoji conventionalisation. Instead, GenZ reported having the smallest online social networks: more than half of GenZ participants reported that their daily online interactions were confined to a small set of less than six people, whereas more than half of older adults who were members of the GenX/Boomers generation reported exchanging messages with between 6 and 20 people. If anything, we found the opposite pattern, whereby GenX/BabyBoomers reported the largest social networks (but see discussion of limitations below). We also did not observe self-reported inter-generational differences in emoji usage, which is in contrast with previous studies that found lower emoji usage in older people (An et al., 2018; Boutet et al., 2024; (Emogi Consumer Science Team, 2015); Herring & Dainas, 2020; Koch et al., 2022; Wu et al., 2024). There were, however, differences in frequency of online usage: GenZ participants reported sending text messages more frequently than GenX/Baby Boomers and checking social media more frequently than both Millennials and GenX/Baby Boomers. This paints a picture according to which GenZ may have fewer but more intense online social connections than the older cohorts.

There are good reasons to believe that the lack of an age-related decline in online social network size observed here is indeed reliable. Recent qualitative research suggests that many older adults are making extensive use of online communication to broaden and adjust their social networks, and to overcome the limitations of physical proximity to suit their specific social needs (Quan-Haase et al., 2019). This trend may have counteracted the expected reductions in social network size over the lifespan that is typically observed in *offline* communication (Bruine de Bruin et al., 2020; English & Carstensen, 2014; Wrzus et al., 2013). The few studies that similarly observed smaller *online* social networks in older people are over a decade old, with data collection having taken place more than 10 years ago (Pfeil et al., 2009; Chang et al., 2015; Yu et al., 2018). It is conceivable that, since online communication has become more and more ubiquitous and multi-functional over time, age-related reductions in online social network size may have been attenuated over the past decade. It should also be noted that our data collection took place soon after the COVID19-pandemic, during which much of social interaction had shifted online – resulting in increased social media use (e.g. Lemenager et al., 2021; Luo et al., 2021; Thygesen et al., 2021). This provides further opportunity for levelling age-related differences in online social network sizes, albeit within the constraints of demographic differences in digital access (Nguyen et al., 2020). Future research using more sophisticated methods for estimating online social network size will have to confirm whether older adults have indeed undergone an expansion of online social networks as our findings tentatively suggest.

What might explain the expanded online social networks in older cohorts as well as the lack of inter-generational differences in conventionalisation and interpretation emojis, construed as a novel semiotic system? A possible explanation is that age differences in emoji conventionalisation and interpretation may not be measurable anymore after a decade of global use. Although the broad repertoire of emojis was introduced merely a decade ago, the steady increase in online communication across all ages may have facilitated the ongoing process of conventionalisation of many emoji meanings across different user groups. Viewed from a historical perspective, the differences in agreement on emoji meanings observed in various studies (Częstochowska et al., 2022; Miller et al., 2016; Weissman et al., 2023) can be seen as snapshots on a trajectory of increasing conventionalisation and lexicalisation of multi-modal form-meaning mappings over time (Jackendoff & Audring, 2020). In fact, tracking of semantic change of emojis from 2012 to 2018 revealed little such change for most emojis, and mainly seasonal change or a shift to figurative use for just a few (Robertson et al., 2021), suggesting that emoji meanings may indeed have quite quickly become conventionalised and their interpretations are now more entrenched globally. Thus, the trajectory of conventionalisation over time, as well as the increased ubiquity of online communication across all generations may explain why age differences in emoji interpretation and in interpretation agreement were not detected in the sizeable sample we tested in 2022.

Another reason for why we did not observe an effect of online social network size is that emoji conventionalisation may also be driven by super-nodes in online networks, e.g. influencers with large number of followers posting on social media sites designed to algorithmically amplify their reach. Such a mechanism would be compatible with a well-attested social learning bias, the prestige bias: It is advantageous to learn from successful individuals but because success is difficult to evaluate prestige is often taken as an indirect marker of success (Henrich & Gil-White, 2001). If participants were exposed to emoji use by such super-nodes in online social networks, their influence may have overridden any potential effect of the size of social networks comprised of one-to-one interactions of the kind we attempted to measure. As we did not include an estimate for the exposure to super-nodes in online social networks their effect on emoji conventionalisation, or conventionalisation of novel signs more broadly, must remain speculative until further direct evidence can be obtained.

4.1. Limitations

Our findings need to be caveated by the fact that participants in this study were asked to interpret out-of-context emojis. Although previous work on the lexicalisation of emojis (Weissman et al., 2023) suggested that out-of-context presentation is a reasonable starting point for comparing the degree of conventionalisation across different user groups, there is work showing that emoji interpretation can be context-dependent (Miller et al., 2017; Weissman, 2019). Specifically, studies that examined how emojis are incorporated into text messages either by using donated WeChat (An et al., 2018) and WhatsApp messages (Koch et al., 2022) showed subtle age differences, e.g. with respect to preference for positive vs negative emojis. It is therefore possible that a text-based dataset would have yielded a different outcome, and that there may be generational differences in the kinds of face emojis that people select to accompany their texts. Thus, by focussing on denotative emoji meanings, this study serves as a starting point to explore inter-generational differences in conventionalisation of emojis as novel signs. Future research should extend this work by exploring inter-generational differences in emoji connotations, e.g. in degree of agreement on pragmatic emoji use in specific contexts, which may be more prone to group differences.

A further caveat is related to the possibility that generational differences in emoji interpretation may affect emojis that were not included in this study. Although we examined a set of 24 face emojis and 10 filler emojis—a number that exceeds the amount of emojis typically tested in recent studies (Chen et al., 2024; Boutet et al., 2024)—it obviously does not encompass the entire range of emojis used by people in daily online interaction. For example, when collecting ratings for 74 face emojis, Kutsuzawa et al. (2022) found a subtle age difference affecting only a small subset of emojis for this large set: older participants reported greater subjective arousal for emojis with negative emotional valence. Although our medium-size set was designed to strike a balance between face emoji representativeness and feasibility of survey administration, future studies may want to expand the set of items to see whether differences in intra-generational conventionalisation affect certain subsets of emojis.

Another limitation is that the lack of inter-generational differences in social network size may have been the result of our chosen survey method, particularly our use of an explicit single-item question for estimating social network size. This question (*"On average, how many people do you exchange messages with regularly, excluding email and broadcasting to followers on twitter, instagram etc?"*) may have been open to misinterpretation such that participants may not have understood that broadcasting (i.e. sending texts to multiple potentially unknown addressees, as is possible in WhatsApp group chats) should be excluded from their estimate. As a result, it is conceivable that this may have led to an overestimation of online social network size, especially in the older generations who may have been unsure about the meaning of 'broadcasting' in this context. In addition, in our attempt to restrict participants' responses to direct contacts only, the question may have been unnecessarily syntactically complex, further hampering comprehension. We therefore cannot be sure of the reliability of self-reports of online social network size. However, the response categories that would have been indicative of inclusion of broadcasting-style messages to followers or group members rather than direct interaction ("21–100", "101–200", "201–1000") were selected less than 20 % of the time in all generations, with the last two categories being selected less than 3 % of the time. This suggests that any misinterpretation of this question, if it took place at all, would have had a minimal effect.

Another interesting point to consider is that older adults' online social networks tend to encompass all age groups, whereas younger people communicate mainly with other young people belonging to their own age group (Pfeil et al., 2009). If the age distribution of older people's online network is variable enough to also include a sizeable number of young people, then any generational differences in emoji meanings are bound to diminish over time thanks to reverse-vertical transmission (i.e., when older adults learn from adolescents, e.g., Lew-Levy & Amir, 2024). Finally, there is evidence that, rather than size, it may be network density that affects conventionalisation of linguistic features (Pardo et al., 2012; Lev-Ari, 2018; Josserand et al., 2024). As such, future work could examine whether differences in the density and composition of online social networks indeed have any impact on emoji agreement and interpretation.

These limitations notwithstanding, our study did not find evidence for generational differences in the conventionalisation, interpretation, and use of face emojis. This finding may be explained by historical trends to do with increasing engagement in online communication in general, and emoji use in particular, by all age cohorts. In this sense, the last decade of emoji use might constitute an example of rapid conventionalisation of a novel semiotic system that has now spread across all demographics with access to online communication.

CRediT authorship contribution statement

Vera Kempe: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Limor Raviv:** Writing – review & editing, Writing – original draft, Visualization, Software, Formal analysis, 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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chbr.2025.100750.

Appendix 1. Target and filler emojis with frequency rank according to https://home.unicode.org/emoji/emoji-frequency/

Emoji Description	Emojipedia Definition	Type	Affective Valence	Freq Rank	Pilot Meaning
Loudly Crying Face	May convey inconsolable grief but also other intense feelings, such as uncontrollable laughter, pride or overwhelming joy.	filler		2	crying
Winking Face	May signal a joke, flirtation, hidden meaning, or general positivity. Tone varies, including playful, affectionate, suggestive, or ironic.	filler		3	wink
Smiling Face with Sunglasses	Often used to convey the slang sense of cool. May also express a confident, carefree attitude or that something is excellent.	filler		4	cool
Thinking Face	Intended to show a person pondering or deep in thought. Often used to question or scorn something or someone, as if saying *Hmm, I don't know about that*. Tone varies, including earnest, playful, puzzled, sceptical, and mocking.	filler		3	thinking
Red Heart	A classic red love heart emoji, used for expressions of love and romance.	filler		0	love
Kiss Mark	Used in place of 'xxx' (kisses), or to send a kiss to someone.	filler		5	kiss
Flexed Biceps	Represents strength or working out.	filler		3	strong
Fire	Commonly used for various metaphorical expressions related to fire, including the slang hot ("attractive") and lit ("excellent").	filler		3	fire
Smiling Face with Smiling Eyes	Often expresses genuine happiness and warm, positive feelings.	filler		2	happy
OK Hand	Represents "I'm okay" or "yes, that's correct/good".	filler		3	ok
Flushed Face	Intended to depict such feelings as embarrassment, but meaning very widely varies. Other senses include flattery, surprise, disbelief, admiration, affection, and excitement.	target	ambiguous	5	
Sleepy Face	While sometimes used to convey sadness, dissatisfaction, or illness, Sleepy Face is also not to be confused with  Crying Face,  Sad but Relieved Face, or other emojis with tear or sweat droplets.	target	negative	5	
Grimacing Face	May represent a range of negative or tense emotions, especially nervousness, embarrassment, or awkwardness (e.g., *Eek!*).	target	negative	5	
Disappointed Face	May convey a variety of unhappy emotions, including disappointment, grief, stress, regret, and remorse.	target	negative	5	
Pouting Face	Bears the same expression as  Angry Face on most platforms and may convey more intense degrees of anger, e.g., hate or rage.	target	negative	5	
Weary Face	May convey various feelings of frustration, sadness, amusement, and affection. Often playful in tone.	target	negative	5	
Downcast Face with Sweat	Usually depicted with a single sweat bead on its right side, though Microsoft includes two.	target	negative	5	
Sad but Relieved Face	Commonly conveys mild degrees of frustration and sadness. Not to be confused with  Crying Face,  Sleepy Face, or other emojis with tear or sweat droplets.	target	negative	5	

(*continued on next page*)

(*continued*)

Emoji Description	Emojipedia Definition	Type	Affective Valence	Freq Rank	Pilot Meaning
Expressionless Face	May convey a sense of frustration or annoyance more intense than suggested by 😐 Neutral Face, as if taking a moment to collect itself.	target	neutral	5	
Smiling Face with Horns	Commonly used to convey mischief, naughtiness, and excitement or excellence (slang, bad or wicked). May also represent devils or devilish behaviour, especially around Halloween. More playful and suggestive than its impish counterpart, 😈 Angry Face With Horns.	target	positive	5	
Kissing Face with Closed Eyes	Commonly conveys sentiments of romantic love and affection.	target	positive	5	
Winking Face with Tongue	Often conveys a sense of fun, excitement, wackiness, buffoonery, or joking.	target	positive	5	
Squinting Face with Tongue	Often conveys a sense of fun, excitement, playfulness, hilarity, and happiness, as if saying *Squee!* or *Awesome!*	target	positive	5	
Face Without Mouth	Meaning widely varies, but commonly conveys speechlessness, humility, and silence. May also convey moderately negative emotions, such as disappointment, frustration, or sadness.	target	ambiguous	6	
Astonished Face	May convey a wide range of emotions, including awe, amazement, admiration, disbelief, excitement, or concern.	target	ambiguous	6	
Persevering Face	May convey various degrees and tones of frustration, sadness, helplessness, and struggle.	target	negative	6	
Face with Steam From Nose	May convey various negative emotions, including irritation, anger, and contempt. May also convey feelings of pride, dominance, and empowerment.	target	negative	6	
Angry Face	Conveys varying degrees of anger, from grumpiness and irritation to disgust and outrage. May also represent someone acting tough or being mean.	target	negative	6	
Tired Face	While intended to represent tiredness, it commonly conveys various degrees and tones of frustration and sadness as well excitement and affection, as if it just can't handle how great someone or something is.	target	negative	6	
Anxious Face with Sweat	Meaning widely varies, but commonly conveys such feelings as sadness, disappointment, fear, and anxiety.	target	negative	6	
Confused Face	While it can convey confusion, it is commonly used for moderate sadness, disappointment, and frustration, thanks to its frown.	target	negative	6	
Face with Open Mouth	May convey such feelings as awe or disbelief, often milder or more ironic in tone than 😱 Face Screaming in Fear.	target	neutral	6	
Neutral Face	Intended to depict a neutral sentiment but often used to convey mild irritation and concern or a deadpan sense of humor.	target	neutral	6	
Face with Tongue	Can variously convey a sense of fun, excitement, silliness, cuteness, happiness, or jesting, as if saying *Just kidding!*	target	positive	6	
Hushed Face	Meaning widely varies, but its expression is commonly taken as surprise, embarrassment, or mild excitement.	target	ambiguous	7	
Upside-Down Face	Commonly used to convey irony, sarcasm, joking, or a sense of goofiness or silliness.	target	ambiguous	7	
Confounded Face	May be used to represent being overcome with various emotions, including irritation, frustration, disgust, and sadness, as if to the point of defeat.	target	negative	7	
Fearful Face	While intended to represent fear (less intense than 😱 Face Screaming in Fear), it also conveys a wide variety of emotions, including feeling amazed, shocked, sad, upset, and cold.	target	negative	7	
Frowning Face	May convey such feelings as moderate concern or disappointment and affectionate sadness, as when missing a loved one.	target	negative	7	

(*continued on next page*)

(*continued*)

Emoji Description	Emojipedia Definition	Type	Affective Valence	Freq Rank	Pilot Meaning
Worried Face	May convey a variety of moderately sad or tense emotions, including concern, anxiety, alarm, disappointment, and unhappiness.	target	negative	7	
Slightly Frowning Face	Often conveys a mild degree of concern, disappointment, or sadness, but usually less intensely than Frowning Face.	target	negative	7	
Zipper-Mouth Face	Meaning widely varies, but commonly conveys a secret or that someone will keep one (e.g., *My lips are sealed*). May also be used to tell someone to stop talking (e.g., *Zip it!* or *I'll shut up now*).	target	neutral	7	
Money-Mouth Face	Used for a wide range of content dealing with money, including: making money, loving wealth, being or feeling rich, and concepts of success and excellence (e.g., *on the money*).	target	neutral	7	
Dizzy Face	May convey a heightened or hyperbolic sense of such feelings as shock, surprise, disbelief, awe, and amazement, as if staggered to the point of disorientation (i.e., dizzy). May also represent sickness, nausea, intoxication, and death, e.g., slang *I'm dead!*	target	neutral	7	
Kissing Face	Like	target	positive	7	
Kissing Face with Smiling Eyes	Kissing Face With Smiling Eyes, this emoji is sometimes taken to represent whistling, especially when paired with a musical note. May convey such feelings as surprise, admiration, contempt, or feigned innocence, as a person casually whistling after wrongdoing saying, Nothing to look at here. Commonly conveys sentiments of love and affection.	target	positive	7	

Data availability

Link to data and code on the OSF is shared in the article.

References

An, J., Li, T., Teng, Y., & Zhang, P. (2018). Factors influencing emoji usage in smartphone mediated communications. In *International conference on information* (pp. 423–428). Cham: Springer International Publishing.

Bahlmann, M. D. (2014). Geographic network diversity: How does it affect exploratory innovation? *Industry & Innovation, 21*(7–8), 633–654.

Barach, E., Feldman, L. B., & Sheridan, H. (2021). Are emojis processed like words? Eye movements reveal the time course of semantic processing for emojified text. *Psychonomic Bulletin & Review, 28*, 978–991.

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models Usinglme4. *Journal of Statistical Software, 67*(1).

Boutet, I., Goulet-Pelletier, J. C., Sutera, E., & Meinhardt-Injac, B. (2024). Are older adults adapting to new forms of communication? A study on emoji adoption across the adult lifespan. *Computers in Human Behavior Reports, 13*, Article 100379.

Bruine de Bruin, W., Parker, A. M., & Strough, J. (2020). Age differences in reported social networks and well-being. *Psychology and Aging, 35*(2), 159.

Bürkner, P. C. (2017). Brms: An R package for Bayesian multilevel models using stan. *Journal of Statistical Software, 80*, 1–28.

Capobianco, M. (2022). I asked teenagers, 30-Somethings, and people in their 50s what these emojis mean, and I got verrry different responses from each generation. *BuzzFeed*. Retrieved at https://www.buzzfeed.com/mollycapobianco/different-generations-emoji-use.

Chang, P. F., Choi, Y. H., Bazarova, N. N., & Löckenhoff, C. E. (2015). Age differences in online social networking: Extending socioemotional selectivity theory to social network sites. *Journal of Broadcasting & Electronic Media, 59*(2), 221–239.

Chen, Y., Yang, X., Howman, H., & Filik, R. (2024). Individual differences in emoji comprehension: Gender, age, and culture. *PLoS One, 19*(2), Article e0297379.

Częstochowska, J., Gligorić, K., Peyrard, M., Mentha, Y., Bień, M., Grütter, A., … West, R. (2022). On the context-free ambiguity of emoji. In *Proceedings of the international AAAI conference on web and social media* (Vol. 16, pp. 1388–1392).

De Vos, C. (2011). Kata Kolok color terms and the emergence of lexical signs in rural signing communities. *The Senses and Society, 6*(1), 68–76.

DiGirolamo, M. A., & Russell, J. A. (2017). The emotion seen in a face can be a methodological artifact: The process of elimination hypothesis. *Emotion, 17*(3), 538.

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

Emogi Consumer Science Team. (2015). *Emoji report. emogi.com/documents/Emoji_Report_2015.pdf*.

English, T., & Carstensen, L. L. (2014). Selective narrowing of social networks across adulthood is associated with improved emotional experience in daily life. *International Journal of Behavioral Development, 38*(2), 195–202.

Fagyal, Z., Swarup, S., Escobar, A. M., Gasser, L., & Lakkaraju, K. (2010). Centers and peripheries: Network roles in language change. *Lingua, 120*(8), 2061–2079.

Fricke, L., Grosz, P. G., & Scheffler, T. (2024). Semantic differences in visually similar face emojis. *Language and Cognition*, 1–15.

Fullwood, C., Orchard, L. J., & Floyd, S. A. (2013). Emoticon convergence in internet chat rooms. *Social Semiotics, 23*(5), 648–662.

Gallud, J. A., Fardoun, H. M., Andres, F., & Safa, N. (2018). A study on how older people use emojis. In *Proceedings of the XIX international conference on human computer interaction* (pp. 1–4).

Gong, T., Baronchelli, A., Puglisi, A., & Loreto, V. (2012). Exploring the roles of complex networks in linguistic categorization. *Artificial Life, 18*(1), 107–121.

Granovetter, M. (1983). The strength of weak ties: A network theory revisited. *Sociological Theory, 1*(1983), 201–233.

Hayes, G. S., McLennan, S. N., Henry, J. D., Phillips, L. H., Terrett, G., Rendell, P. G., … Labuschagne, I. (2020). Task characteristics influence facial emotion recognition age-effects: A meta-analytic review. *Psychology and Aging, 35*(2), 295.

Henrich, J., & Gil-White, F. J. (2001). The evolution of prestige: Freely conferred deference as a mechanism for enhancing the benefits of cultural transmission. *Evolution and Human Behavior, 22*(3), 165–196.

Herring, S. C., & Dainas, A. R. (2020). Gender and age influences on interpretation of emoji functions. *ACM Transactions on Social Computing, 3*(2), 1–26.

Jackendoff, R., & Audring, J. (2020). *The texture of the lexicon: Relational morphology and the parallel architecture*. Oxford University Press.

Jaeger, S. R., Xia, Y., Lee, P. Y., Hunter, D. C., Beresford, M. K., & Ares, G. (2018). Emoji questionnaires can be used with a range of population segments: Findings relating to age, gender and frequency of emoji/emoticon use. *Food Quality and Preference, 68*, 397–410.

Josserand, M., Allassonnière-Tang, M., Pellegrino, F., Dediu, D., & de Boer, B. (2024). How network structure shapes languages: Disentangling the factors driving variation in communicative agents. *Cognitive Science, 48*(4), Article e13439.

Kaye, L. K., Malone, S. A., & Wall, H. J. (2017). Emojis: Insights, affordances, and possibilities for psychological science. *Trends in Cognitive Sciences, 21*(2), 66–68.

Ke, J., Gong, T., & Wang, W. S. (2008). Language change and social networks. *Communications in Computational Physics, 3*(4), 935–949.

Koch, T. K., Romero, P., & Stachl, C. (2022). Age and gender in language, emoji, and emoticon usage in instant messages. *Computers in Human Behavior, 126*, Article 106990.

Kutsuzawa, G., Umemura, H., Eto, K., & Kobayashi, Y. (2022). Age differences in the interpretation of facial emojis: Classification on the arousal-valence space. *Frontiers in Psychology, 13*, Article 915550.

Lemenager, T., Neissner, M., Koopmann, A., Reinhard, I., Georgiadou, E., Müller, A., … Hillemacher, T. (2021). COVID-19 lockdown restrictions and online media consumption in Germany. *International Journal of Environmental Research and Public Health, 18*(1), 14.

Lev-Ari, S. (2018). Social network size can influence linguistic malleability and the propagation of linguistic change. *Cognition, 176*, 31–39.

Luangrath, A. W., Peck, J., & Barger, V. A. (2017). Textual paralanguage and its implications for marketing communications. *Journal of Consumer Psychology, 27*(1), 98–107.

Luo, T., Chen, W., & Liao, Y. (2021). Social media use in China before and during COVID-19: Preliminary results from an online retrospective survey. *Journal of Psychiatric Research, 140*, 35–38.
Lutzenberger, H., Mudd, K., Stamp, R., Schembri, A. C., & Schembri, A. (2023). The social structure of signing communities and lexical variation: A cross-linguistic comparison of three unrelated sign languages. *Glossa: A journal of General Linguistics, 8*(1).
Meir, I., Israel, A., Sandler, W., Padden, C. A., & Aronoff, M. (2012). The influence of community on language structure: evidence from two young sign languages. *Linguistic Variation, 12*(2), 247–291.
Meir, I., & Sandler, W. (2019). Variation and conventionalization in language emergence. *Language contact, continuity and change in the genesis of modern Hebrew, 256*, 337.
Miller, H., Kluver, D., Thebault-Spieker, J., Terveen, L., & Hecht, B. (2017). Understanding emoji ambiguity in context: The role of text in emoji-related miscommunication. *Proceedings of the 11th international AAAI conference on web and social media*.
Miller, H., Thebault-Spieker, J., Chang, S., Johnson, I., Terveen, L., & Hecht, B. (2016). "Blissfully happy" or "ready to fight": Varying interpretations of emoji. In *Proceedings of the international AAAI conference on web and social media* (Vol. 10, pp. 259–268), 1.
Milroy, J., & Milroy, L. (1985). Linguistic change, social network and speaker innovation1. *Journal of Linguistics, 21*(2), 339–384.
Mudd, K., de Vos, C., & De Boer, B. (2022). Shared context facilitates lexical variation in sign language emergence. *Languages, 7*(1), 31.
Nguyen, M. H., Gruber, J., Fuchs, J., Marler, W., Hunsaker, A., & Hargittai, E. (2020). ?covid19?> changes in digital communication during the COVID-19 global pandemic: Implications for digital inequality and future research. *Social Media + Society, 6*(3), Article 2056305120948255.
Pardo, J. S., Gibbons, R., Suppes, A., & Krauss, R. M. (2012). Phonetic convergence in college roommates. *Journal of Phonetics, 40*, 190–197.
Pfeil, U., Arjan, R., & Zaphiris, P. (2009). Age differences in online social networking–A study of user profiles and the social capital divide among teenagers and older users in MySpace. *Computers in Human Behavior, 25*(3), 643–654.
Quan-Haase, A., Zhang, R., Wellman, B., & Wang, H. (2019). *Older adults on digital media in a networked society. Society and the internet* (pp. 96–108).
Robertson, A., Liza, F. F., Nguyen, D., McGillivray, B., & Hale, A. S. (2021). Semantic journeys: Quantifying change in emoji meaning from 2012–2018. In *Workshop proceedings of the 15th international AAAI conference on web and social media*.
Rohrer, J. M. (2025). Thinking clearly about age, period, and cohort effects. *Advances in Methods and Practices in Psychological Science, 8*(2), Article 25152459251342750.
Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin, 115*(1), 102.
Shaw-Ching Liu, B., Madhavan, R., & Sudharshan, D. (2005). DiffuNET: The impact of network structure on diffusion of innovation. *European Journal of Innovation Management, 8*(2), 240–262.
Thompson, B., Raviv, L., & Kirby, S. (2019). Complexity can be maintained in small populations: A model of lexical variability in emerging sign. In *Interaction and the evolution of linguistic complexity workshop*.
Thygesen, H., Bonsaksen, T., Schoultz, M., Ruffolo, M., Leung, J., Price, D., & Geirdal, A. Ø. (2021). Use and self-perceived effects of social media before and after the COVID-19 outbreak: A cross-national study. *Health Technology, 11*(6), 1347–1357.
Tkachman, O., & Hudson Kam, C. L. (2020). Measuring lexical and structural conventionalization in young sign languages. *Sign Language and Linguistics, 23*(1-2), 208–232.
Trudgill, P. (2002). Linguistic and social typology. In J. K. Chambers, P. Trudgill, & N. Schilling-Estes (Eds.), *The handbook of language variation and change* (pp. 707–728). Malden, MA: Blackwell.
Trudgill, P. (2009). Sociolinguistic typology and complexification. In G. Sampson, D. Gil, & P. Trudgill (Eds.), *Language complexity as an evolving variable* (pp. 98–109). Oxford, UK: Oxford University Press.
Venables, W. N., & Ripley, B. D. (2002). *Modern applied statistics with S* (4th ed.). New York: Springer.
Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences, 39*(2), 273–315.
Waldman, K. (2016). How do olds use emoji? Incorrectly, according to wired. *Slate*. Retrieved from https://slate.com/technology/2016/08/how-do-olds-use-emoji.html.
Weckler, A. (2023). *Still using emoji? Your smiley face is showing your age*. Irish Independent. Retrived at https://www.independent.ie/business/technology/still-using-emoji-your-smiley-face-is-showing-your-age/a386054154.html.
Weissman, B. (2019). Peaches and eggplants or… something else? The role of context in emoji interpretations. *Proceedings of the Linguistic Society of America, 4*(1), 29.
Weissman, B., Engelen, J., Baas, E., & Cohn, N. (2023). The lexicon of emoji? Conventionality modulates processing of emoji. *Cognitive Science, 47*(4), Article e13275.
Wrzus, C., Hänel, M., Wagner, J., & Neyer, F. J. (2013). Social network changes and life events across the life span: A meta-analysis. *Psychological Bulletin, 139*(1), 53.
Wu, D., Zhang, X., & Zhang, X. (2024). Is there an intergenerational discrepancy in the comprehension and aesthetic preference regarding emoji usage? Evidence from WeChat. *Frontiers in Psychology, 15*, Article 1424728.
YouGov. (2023). https://today.yougov.com/topics/society/survey-results/daily/2023/12/12/10c28/1.
Yu, R. P., Ellison, N. B., & Lampe, C. (2018). Facebook use and its role in shaping access to social benefits among older adults. *Journal of Broadcasting & Electronic Media, 62*(1), 71–90.
Lew-Levy, S., & Amir, D. (2024). Children as agents of cultural adaptation. *Behavioral and Brain Sciences*, 1–68.