



# Impact of contextual and personal determinants on online social conformity

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## ABSTRACT

Despite decades of research concerning social conformity and its effects on face-to-face groups, it is yet to be comprehensively investigated in online contexts. In our work, we investigate the impact of contextual determinants (such as majority group size, the number of opposing minorities and their sizes, and the nature of the task) and personal determinants (such as self-confidence, personality and gender) on online social conformity. In order to achieve this, we deployed an online quiz with subjective and objective multiple-choice questions. For each question, participants provided their answer and self-reported confidence. Following this, they were shown a fabricated bar chart that positioned the participant either in the majority or minority, presenting the distribution of group answers across different answer options. Each question tested a unique group distribution in terms of the number of minorities against the majority and their corresponding group sizes. Subsequently, participants were given the opportunity to change their answer and reported confidence. Upon completing the quiz, participants undertook a personality test and participated in a semi-structured interview. Our results show that 78% of the participants conformed to the majority's answers at least once during the quiz. Further analysis reveals that the tendency to conform was significantly higher for objective questions, especially when a participant was unsure of their answer and faced an opposing majority with a significant size. While we saw no significant gender differences in conformity, participants with higher conscientiousness and neuroticism tended to conform more frequently than others. We conclude that online social conformity is a function of majority size, nature of the task, self-confidence and certain personality traits.

## 1. Introduction

Conformity is a powerful social phenomenon that encourages individuals to change their personal opinions and behaviour to agree with an opposing majority (*i.e.* the greater proportion of the group members with a contradicting opinion or behaviour) (Asch, 1951). Such behaviour is predominantly visible as we tend to fit in to our social groups, to be 'liked' and to be 'right' (Deutsch & Gerard, 1955). In other words, social conformity can lead to people not expressing their own judgements and opinions when facing peer pressure in groups, which could be detrimental to the effectiveness of groups in decision making and innovative thinking (Kaplan & Miller, 1987).

This psychological mechanism has been widely studied with regard to face-to-face groups, specifically focusing on its diverse contextual and personal determinants. For example, it was observed that when placed in a group setting, the likelihood of an individual conforming to the majority was influenced by various contextual factors such as the size of the majority group (Asch, 1956; Gerard, Wilhelmy, & Conolley, 1968) and the nature and difficulty of the task at hand (*i.e.* objective

tasks with one correct answer or subjective tasks where the answer is based on or influenced by personal feelings, tastes, or opinions) (Blake, Helson, & Mouton, 1957; Coleman, Blake, & Mouton, 1958). Moreover, literature suggests that personal factors such as participant gender (Eagly & Chvala, 1986), self-confidence (Rosenberg, 1963) and personality (Crutchfield, 1955) may also impact susceptibility to social conformity differently.

However, it is unclear to what extent observations resulting from these seminal studies apply to online settings. This is of particularly importance as our social interactions increasingly shift to diverse online paradigms such as discussion forums, social media, polls and learning platforms (Goncalves, Kostakos, & Venkatanathan, 2013; Reynolds, Venkatanathan, Goncalves, & Kostakos, 2011). As such online groups are inherently dissimilar to face-to-face groups in terms of anonymity and reduced social presence (McKenna & Green, 2002), their susceptibility to social conformity is likely to vary. While existing literature provide some evidence for the presence of conformity in computer-mediated settings (Beran, Drefs, Kaba, Al Baz, & Al Harbi, 2015;

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Cinnirella & Green, 2007; Sharma & De Choudhury, 2018; Sukumaran, Vezich, McHugh, & Nass, 2011), and evaluate the effects of several aforementioned factors independently (Laporte, van Nimwegen, & Uytendaele, 2010; Lowry, Roberts, Romano Jr, Cheney, & Hightower, 2006; Rosander & Eriksson, 2012), they fail to assess the combined effects of such determinants. We argue that understanding the collective impact of such determinants could better explain their relative importance while also rationalising conformity behaviour. Thus, we extend the existing literature by thoroughly exploring possible direct and combined effects of contextual and personal determinants of conformity in anonymous online settings. While online settings differ from face-to-face settings in aspects beyond anonymity (e.g. social presence), we do not investigate aspects of online social interactions beyond anonymity in the current study.

To explore online social conformity as a function of contextual and personal determinants, we deployed an online quiz with multiple-choice questions (MCQs) of objective and subjective nature. Participants first answered each question privately while denoting their self-reported confidence on the selected answer. Next, our software displayed the distribution of votes across the different answer options of the MCQ, as chosen by other participants. Participants were then given the opportunity to change their initial answer and self-reported confidence. We also collected Big-five personality test scores (where personality is identified in terms of openness, conscientiousness, extraversion, agreeableness, and neuroticism) (John & Srivastava, 1999), to assess the personality of each participant towards the end of the quiz. Through our study we investigate the following research questions with regard to online social conformity:

**RQ1: How do contextual determinants like majority and minority group sizes, number of minorities present and nature of the task impact the likelihood of an individual conforming to the majority's judgement in an online setting?**

**RQ2: How do personal determinants like gender, self-confidence and personality impact the likelihood of an individual conforming to the majority's judgement in an online setting?**

## 2. Related work

### 2.1. Conformity in face-to-face groups

Social conformity was first explored in physical face-to-face groups. Asch's conformity experiments (Asch, 1951, 1955) were pivotal among early research on social conformity, where about a third of the participants conformed to a clearly incorrect yet unanimous majority, in a simple line matching task, confirming that individual judgements can be swayed under pressure. A subsequent study by Deutsch and Gerard (1955) rationalised conformity behaviour as having 'normative' and 'informational' influences. The authors described 'normative influence' as the tendency to conform to expectations of the majority to be 'liked' within the group. Accepting the majority's judgement to be more accurate than one's own judgement (especially in ambiguous situations) was explained as 'informational influence'. The impact of 'normative influences' was further confirmed by more recent work where conformity was seen as an outcome of individuals' desire to fit in with the group (Levine, 1999) and ensure a sense of belonging (Cialdini & Goldstein, 2004). Moreover, Levine (1999) emphasised the effects of 'informational influence' on conformity, where individuals turn to groups for guidance in ambiguous situations where the 'correct' response is unclear.

Further studies on face-to-face social conformity have primarily focused on identifying contextual and personal determinants of conformity. Literature reveals that rates of conformity vary based on contextual factors such as the majority group size (Asch, 1956; Bond, 2005; Gerard et al., 1968) and the nature of the task (Blake et al., 1957; Coleman et al., 1958). In addition to contextual determinants, personal factors such as gender (Eagly, 1983; Eagly & Chvala, 1986; Eagly

& Wood, 1985), self-confidence (Mausner, 1954; Mausner & Bloch, 1957; Rosenberg, 1963; Samelson, 1957) and an individual's anxiety levels (Meunier & Rule, 1967) have been identified as important determinants of social conformity.

Despite the extensive literature on social conformity in face-to-face groups, this form of social influence is currently underexplored for computer-mediated online groups. As human interactions increasingly shift towards online platforms (Goncalves et al., 2013; Reynolds et al., 2011), whether and how social conformity manifests in virtual groups is of interest to the research community. Next, we review previous work on conformity in online settings, and identify the gaps in the literature that we aim to address in our work.

### 2.2. Conformity in online settings

Due to the rapid advancements of the Internet, individuals are actively interacting with each other through diverse online platforms (e.g., discussion forums, support groups, learning platforms) to satisfy their informational and social requirements (Goncalves et al., 2013; Reynolds et al., 2011). Thus, one can argue that social influences affecting people in face-to-face groups may also manifest in online settings.

Cinnirella and Green (2007) explored the susceptibility of individuals to 'normative influence' in computer-mediated groups. The study extended Asch's line experiment by allowing participants to select their answers through computer-mediated communication (a personal computer), offering them anonymity. Similar to Asch's experiment, the participants saw a majority (consisting of confederates of the researcher) providing a uniformly incorrect response, before they gave their personal answer. The results of this experiment were compared against a traditional face-to-face situation in which participants answered the same test in physical groups. The study concluded that while conformity was significantly reduced in the anonymous computer-mediated group condition when compared to the face-to-face condition, the unidirectional feedback from an anonymous and contradicting majority was sufficient to trigger conformity behaviour. Similar findings were put forward by Smilowitz, Compton, and Flint (1988), confirming the above conclusion.

Despite being criticised for its negative impact on group decision making and productivity (Deutsch & Gerard, 1955), literature displays both positive and negative implications of social conformity in online settings. For example, work by Sukumaran et al. (2011) investigated how social conformity may encourage adapting to acceptable standards and structure within online communities. The study was conducted on an online news website, where participants saw a set of 'high-thoughtful' or 'low-thoughtful' comments added by prior users for a news item, before they were asked to post their own comments. The results of this study emphasised that 'high-thoughtful' comments added by prior users motivated subsequent participants to contribute with similar or additional effort, even when there was no other interaction between the participants and the previous users. The study confirmed the existence of 'normative influence' and social conformity, and its applicability in shaping the amount of effort users put into their contributions in online communities.

However, a more recent study by Beran et al. (2015) exploring conformity among graduate students in a virtual learning environment revealed contradicting observations. This study deployed an online quiz on curriculum-based tasks, where a proportion of the participants were shown incorrect peer answers prior to answering the questions, while the others attempted the quiz independently. Authors observed that a significant proportion of students conformed to the incorrect responses of their peers, despite the static and unidirectional nature of the peer feedback. Students rationalised their conformity behaviour as an outcome of self-doubt and lack of knowledge on the tested content, emphasising the effect of 'informational influence' on conformity. More interestingly, students who were shown peer answers were seen to

obtain fewer correct answers than the students who completed the quiz by themselves.

Furthermore a study by [Sharma and De Choudhury \(2018\)](#) explained how individuals seeking support from online support groups were encouraged to conform to accepted group norms of communication, to receive better support. Individuals who conformed to the group's linguistic norms received more positive support and feedback than the ones who did not. On one hand, conforming to group norms improved the sense of belonging and security within the community, so that sensitive mental health issues could be openly discussed. However, authors also argued that pressure to conform to the group's norms may cause unnecessary distress to individuals seeking support from online communities.

Having acknowledged that social conformity can have mixed effects in online social groups, we argue that in order to derive positive outcomes through this powerful social influence, a thorough understanding of its determinants is required. While literature on social conformity in face-to-face groups may lay adequate groundwork, it is important to recognise that online groups are inherently dissimilar to face-to-face groups due to anonymity and reduced social presence they provide ([McKenna & Green, 2002](#)). Thus, the dynamics and implications of social conformity in online environments could be considerably dissimilar to that of physical face-to-face groups. While we acknowledge that online settings differ from face-to-face settings in aspects beyond anonymity, in this work we thoroughly investigate the effects of contextual and personal determinants of social conformity in an anonymous online setting with static and unidirectional peer feedback.

### 2.3. Contextual determinants of social conformity

Early literature exploring the determinants of social conformity attempted to explain conformity as an outcome of various contextual factors. Among such determinants group size of the influencing source (the majority) and the nature of the task has been prominently researched ([Asch, 1951, 1955](#); [Blake et al., 1957](#); [Deutsch & Gerard, 1955](#); [Ferguson, 1944](#); [Gerard et al., 1968](#); [Latané & Wolf, 1981](#); [Stang, 1976a](#)).

Quantifying the effect of majority group size on conformity has been an interest of many researchers and a variety of theories have been put forward. For instance, [Asch \(1955\)](#) noted that against a minority of one, the influential power of the majority increased until its third member. Adding a fourth member to the majority did not generate a higher conformity influence. This notion was further established by subsequent experiments on group size and conformity ([Gerard et al., 1968](#); [Stang, 1976a](#)). Moreover, a study by [Insko, Smith, Alicke, Wade, and Taylor \(1985\)](#) rationalised that larger majorities exert more pressure on individuals to conform as a result of higher 'normative' and 'informational' influences. [Latané and Wolf \(1981\)](#) further expanded this understanding by exploring the incremental impact generated by each additional member of the majority. They observed that while the influential power of the majority increased as the group grew in size, the incremental impact generated by each additional member reduced.

However, the above studies considered unanimous majorities of varying sizes, against a minority of one (the participant). The studies subsequently failed to determine how the majority's group size would affect conformity in the presence of other minorities, which is a more typical situation in real world group settings.

Furthermore, the impact of majority's size on its ability to trigger conformity among individuals is yet to be explored in online settings. However, a study by [Lowry et al. \(2006\)](#) observed that computer-mediated communication could reduce typical process losses such as conformity visible in larger groups, as compared to face-to-face communication. Thus, it is plausible that online groups may not be affected by adverse influences of social conformity, even with increasing group sizes. However, this notion is yet to be systematically tested in online settings.

Literature also supports the notion that the likelihood of a person conforming to the majority's judgement varies based on the nature of the task at hand. Early experiments on face-to-face groups ([Asch, 1951](#); [Deutsch & Gerard, 1955](#)) explored the effects of conformity in objective tasks while [Ferguson \(1944\)](#) observed conformity manifesting in tasks of attitudinal nature. [Blake et al. \(1957\)](#) compared rates of conformity in questions of both subjective and objective nature to observe that participants conform more to majority's opinions on subjective content than on objective content. The authors concluded that the motivation to achieve correct answers to objective questions outweighed the appeal of conforming to an incorrect majority.

A more recent study by [Laporte et al. \(2010\)](#) reveals similar observations with regard to task difference in online groups. Even though the rates of conformity were significantly lower than in physical groups, higher conformity was visible as participants answered subjective questions, when compared to questions of objective nature. The authors presume that reduced social presence in online contexts (when compared to face-to-face groups), may reduce the effects of 'normative conformance' but does not completely eliminate its effects.

In this study we expand the existing knowledge on the effects of majority and minority group size, number of minorities and nature of the task, by exploring conformity behaviour among individuals in the presence of a range of majority and minority group distributions for tasks of objective and subjective nature.

### 2.4. Personal determinants of social conformity

[Deutsch and Gerard \(1955\)](#) explained that individuals conform to the majority's response when they are unsure of the 'correct' response. In such situations, individuals perceive majority's judgement more likely to be accurate than their own. This implies that confidence in one's personal judgement as well as the judgement of the influencing source, may be important determinants when exploring conformity behaviour. This notion has been investigated in face-to-face groups. For instance, [Samelson \(1957\)](#) observed that participants of an estimation task demonstrated higher conformity when they displayed lower confidence on personal answers and higher confidence on majority's answer. Similar observations were made with regard to self-confidence and confidence on partner's answer in face-to-face groups ([Mausner, 1954](#); [Mausner & Bloch, 1957](#); [Rosenberg, 1963](#)).

The impact of confidence on conformity is yet to be explored in detail with regard to online groups. However, previous work has shown that individuals in online groups who presumed the experimental tasks to be difficult, conformed to incorrect majorities more than those who did not ([Rosander & Eriksson, 2012](#)). Thus, we argue that similar effects of self-confidence on conformity may be visible even in online groups.

As conformity is applicable to all individuals, why certain individuals are more susceptible to its influence than others is a thought-provoking question. Researchers have attributed such changes in susceptibility to differences in personality and character ([Crutchfield, 1955](#); [Ender, 1961](#)). More specifically, [Meunier and Rule \(1967\)](#) observed that higher test anxiety led to more conformity. While there is a substantial amount of work on the impact of personal factors on online behaviour ([Liu, Venkatanathan, Goncalves, Karapanos, & Kostakos, 2014](#); [Venkatanathan, Karapanos, Kostakos, & Goncalves, 2012](#)), not many studies were able to establish a clear relationship between personality and conformity, mostly due to the lack of appropriate tools to assess individual personalities. However, since these early studies, more robust personality assessment tools, such as the Big-five inventory ([John & Srivastava, 1999](#)) have been introduced, which can enable a better understanding of the relationship between personality and conformity in online groups.

Furthermore, gender differences and its impact on group conformity is a well-researched area in literature. Early literature emphasised that women were more susceptible to external influences than men ([Eagly, 1983](#)). Thus, women were seen to conform more frequently than men

under group settings (Eagly & Chvrvala, 1986). This observation was explained as an outcome of social roles imposed on individuals such that, men were expected to be task-oriented while women were expected to be cooperative and considerate of the group goals (Eagly & Wood, 1985). Expectations to adhere to such gender roles may have contributed to differences in conformity behaviour among men and women.

However, literature exploring effects of gender on conformity in computer-mediated groups are inconclusive. While some confirm that women are more likely to conform to the majority's opinion than men (Adrianson, 2001), more recent studies observe no statistically significant gender differences with regard to conformity behaviour in online settings (Rosander & Eriksson, 2012). Thus, more work is required under this topic.

Based on the cumulative evidence provided by existing literature, we observe that conformity is a function of multiple contextual and personal determinants and thus needs to be explored from a wider perspective in order to truly understand the factors at play.

### 3. Method

We conducted our experiment as an online quiz with multiple-choice questions (MCQ). MCQ quizzes have been widely utilised in many recent studies related to online social conformity (Beran et al., 2015; Laporte et al., 2010; Rosander & Eriksson, 2012). This methodological decision enabled us to control the independent variables (such as group distributions and question types) to suit the requirements of the experiment, while simulating a plausible real world online environment.

Our experiment was approved by the Human Research Ethics Committee at our university. Informed written consent was obtained from each participant prior to data collection. Each participant spent 60 min completing the experiment, which included an individual briefing session, training, completing the quiz, and a final face-to-face interview. Participants received a \$15 gift voucher for participation.

#### 3.1. The questions

The MCQ quiz contained 34 multiple-choice questions, with an equal distribution of subjective and objective questions. The subjective statements were extracted from a list of high school debating topics published on ThoughtCo ([www.thoughtco.com](http://www.thoughtco.com)). We avoided choosing overly sensitive subjective questions due to ethical concerns as well as the fact that individuals are less likely to change their opinions on such topics. Objective questions included a mix of logic, vocabulary, and general knowledge questions extracted from Mensa International workout ([www.mensa.org](http://www.mensa.org)), Merriam-Webster vocabulary quizzes ([www.merriam-webster.com](http://www.merriam-webster.com)), and Examveda, a well-known general knowledge question repository ([www.examveda.com](http://www.examveda.com)) respectively.

#### 3.2. Participants and procedure

We recruited 50 participants from different educational backgrounds which included Engineering, Science, Arts and Design, Finance and Accounting, Management and Law fields. Participants' age ranged between 18–34 years (women = 25, men = 25). All participants were invited to take part in this study via an online notice board. Interested candidates were asked to complete a screening questionnaire requesting their gender, level of education, and area of expertise. Researchers then filtered out the required quota of participants representing different gender groups, educational levels, and areas of expertise.

The experiment was conducted in a laboratory with one participant per session, under the supervision of a researcher. Participants were informed that the objective of the experiment was to determine the importance of group feedback in online settings, as the true purpose

of the study could not be disclosed prior to the quiz as expected in a conformity study (Stang, 1976b).

Participants then completed an online form which collected their gender, age, and educational background. Upon submitting their demographic details, participants were greeted by a conversational agent named 'QuizBot', which assisted them in familiarising themselves with the environment through two training questions as displayed in Fig. 1.

Training was considered essential in order to ensure that the participants were aware of the process to be followed during the quiz. We utilised the 'QuizBot' to provide step-by-step instructions to participants during the training while minimising the intervention and influence of researchers. This enabled us to simulate a typical online setting where the participants were by themselves.

After training, participants were able to begin the actual quiz. For each question, participants were instructed to select their answer and rate how confident they were with their selection (see Step 1 in Fig. 2). Self-reported confidence levels were denoted using a scale ranging from 0–100 with higher values representing higher levels of confidence.

Subsequently, participants were shown a fabricated bar chart as feedback, claiming to represent how their peers answered the same question (see Step 2 in Fig. 2). A similar approach was successfully leveraged in previous work investigating social conformity (Rosander & Eriksson, 2012). We manipulated the bar charts to position the participants either in the majority or the minority, presenting the distribution of votes across the different choices. The majority–minority group distributions (such as 90%–10%, 80%–20%, 70%–20%–10% etc.) were tested in a random order, while each group size in a given combination was also randomly adjusted by a value between 1% and 4% to ensure their plausibility. For example, in a situation where a 80% majority and a 20% minority needs to be displayed to participants, one participant may see a majority of 82% and a minority of 18% (adjustment factor =  $\pm 2$ ) while another could see a majority of 76% and a minority of 24% (adjustment factor =  $\pm 4$ ), demonstrated through the feedback charts.

Upon seeing the answers of their peers, participants were given the option to maintain their original answer or make changes to the selected answer option and confidence (see Step 3 in Fig. 2).

Beyond assisting with training, the bot kept track of the progress of the participants while also reminding them about the subsequent steps. Moreover, once the feedback charts were displayed for each question, the bot interpreted the results explaining the group distribution among answer options as to avoid any confusion.

For all question items, we recorded the answer options and confidence levels of participants both before and after viewing peer answers. We also note that all participants answered a mix of subjective and objective questions during the quiz. Furthermore, we counterbalanced the presentation of subjective or objective questions for any given group distribution in order to account for possible interactions between group distributions and question type.

Upon completing the quiz, participants were instructed to undertake a self-assessed Big-five personality test online. The personality test included 44 test items extracted from John and Srivastava (1999). Once the personality test was completed, we conducted a semi-structured interview with each participant, in which we debriefed the participants on the true objective of the study. Subsequently, we enquired them about any prior experience facing social pressure in physical or online groups, and whether they felt an urge to change their initial answer during this quiz and why. We were also interested in understanding how participants perceived the group feedback, and the usability and appropriateness of a bot as a training tool (compared to static textual instructions) in online settings.

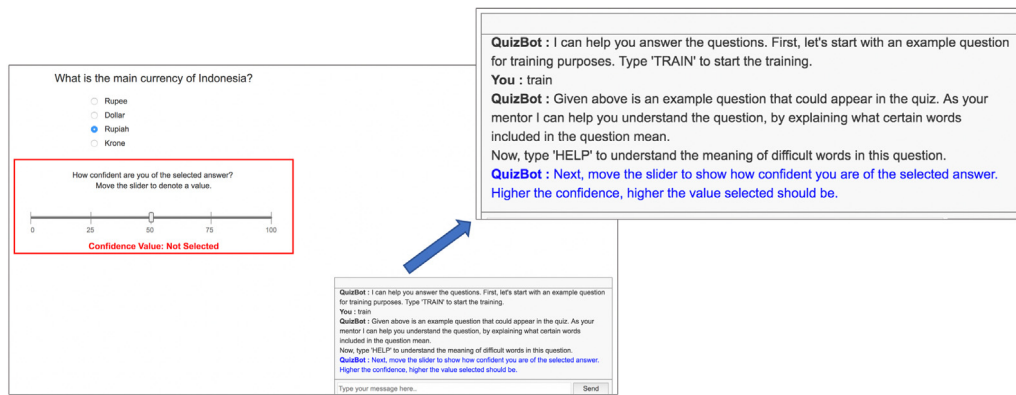


Fig. 1. QuizBot assisting the participants with step-by-step instructions.

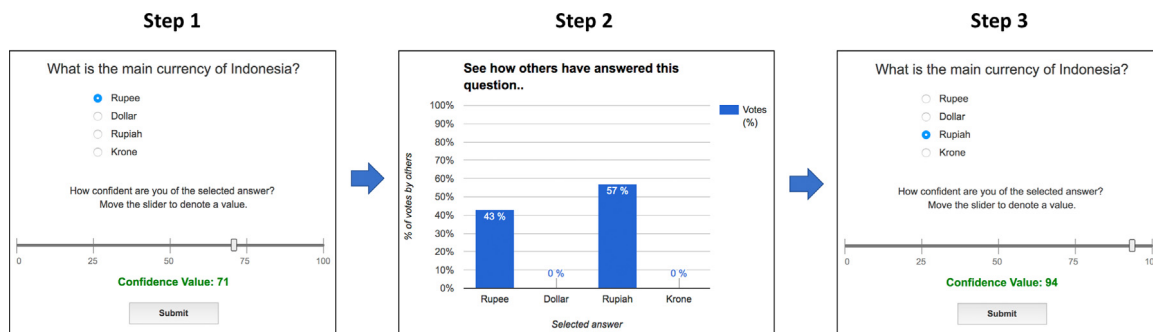


Fig. 2. Steps to be followed during the quiz : (1) Initial answer and confidence (2) Feedback (3) Final answer and confidence.

3.3. Pilot

As the participants were unaware that the feedback they received was fabricated, it was important to decide how the majority and minority groups could be positioned among the four answer options in a credible manner. For example, in a group distribution where the participant would be in the minority of 20%, challenged by a majority of 70% in the presence of another minority of 10%, it was important to decide which answer options should represent the 70% majority and the 10% minority. This placement of majorities and minorities was especially crucial in the subjective questions, where there was no one correct answer.

To address this requirement, we conducted a pilot study with an additional 26 participants (13 men and 13 women). Pilot study participants answered the quiz individually under lab conditions (they were not shown answers of other participants). We observed that for subjective questions results dispersed among at least three answer options. Moreover, for most objective questions a majority selected the correct answer option, while smaller minorities scattered among the other answer options. We arranged the answer options for each question based on the descending order of number of votes it received from the pilot study, to determine a plausible arrangement for the majority and minority groups when fabricating the charts for the main experiment.

4. Results

We collected 36 responses from each of the 50 participants (2 training questions and 34 quiz questions). Responses to training questions were removed from the data set prior to analysis, which resulted in 1700 responses. The participants were in a majority in 800 responses and in a minority for in the remaining 900 responses (equally distributed between objective and subjective questions). We highlight that

our intention was not to compare results between majority and minority groups, but rather explore the impact of diverse group distributions on conformity behaviour among individuals.

Upon receiving group feedback, participants could (a) change both answer option and confidence level, (b) change only their answer option, (c) change only the confidence level, or make no change to the initial answer or confidence. We observed that 92% (46 out of 50) of participants changed their initial response (answer option and/or confidence) at least once during the quiz, resulting in a total of 277 changes with an average of 5.54 changes (SD = 4.14) per person. Out of these 277 changes, 183 were made by participants placed in minorities and the remaining 94 from participants placed in majorities. The distribution of changed responses across three types on post-feedback responses (see a,b and c above) is given in Fig. 3. As expected, the distribution shows that acts of conformity (changing one's answer) occurred predominantly when participants were placed in a minority.

4.1. Model construction

We consider 15 predictors as based on the presented feedback charts, participant demographics, and results from the Big-five personality test (OCEAN). We describe these predictors in detail below:

- **Majority size:** Size of the majority in percentage. Range 40%–90%.
- **Group size:** Size of the group to which the participant was assigned in a given question item (could be either the majority group or a minority group).
- **Group difference:** Difference between the majority group size and the size of the participant's group.
- **Number of minorities:** Number of groups in addition to the majority group. Either 1 or 2.
- **Minority one:** Size of minority one. Range 5%–40%.

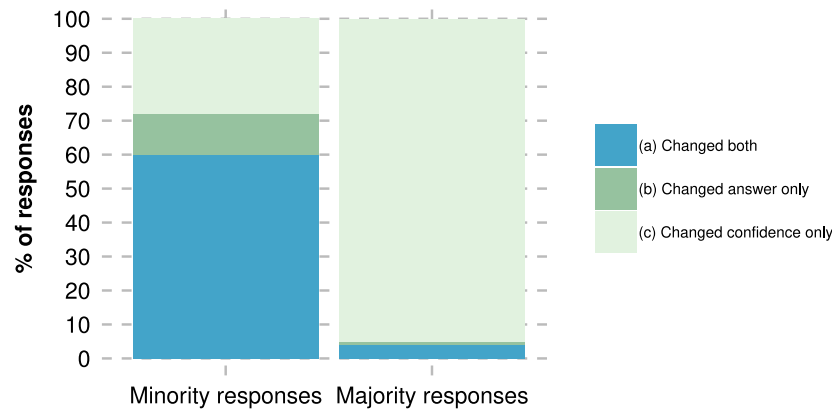


Fig. 3. Distribution of changed responses across three post-feedback response types.

- **Minority two:** Size of minority two (considered only in situations where there were two minorities). Range 5%–40%.
- **Question type:** Subjective or objective question type.
- **Initial confidence:** Participant's confidence in their answer prior to revealing the distribution of group answers. Range 0–100.
- **Gender:** Participant's gender.
- **Openness:** Describes creativity and openness to new experiences. Range 1–100.
- **Conscientiousness:** Describes diligent and goal-directed behaviour. Range 1–100.
- **Extraversion:** Explains emotional expressiveness and outgoing social behaviour. Range 1–100.
- **Agreeableness:** Captures cooperative and considerate behaviour. Range 1–100.
- **Neuroticism:** Captures emotional instability, anxiety and stress levels. Range 1–100.
- **User id:** An unique identifier assigned to a given user during the quiz.

We used the R package *lme4* (Bates, Mächler, Bolker, & Walker, 2015) to perform a generalised linear mixed-effects model (GLMM) analysis of the relationship between the aforementioned predictors and participant conformity. A GLMM allow us to identify the effect of a set of predictors on an outcome variable (conformity) while following an arbitrary (*i.e.* possibly non-normal) distribution. We considered a change in the initial answer option (with or without a change in initial confidence level) to that of the majority, as an indication of conformity behaviour. We observed that in some situations participants also changed their confidence on the selected answer without conforming to the majority's answer option. We specified participant (User id) as a random effect as to allow for individual differences in our model.

Following model selection (incremental removal of variables based on their predictive power), a total of five variables remained. The regression formula of the final model is illustrated by Eq. (1). The estimate values, standard errors (SE), z-values, and p-values of the final model variables are given in Table 1. We performed a likelihood ratio test with the null model (Bolker et al., 2009) and found that our model is statistically significant ( $\chi^2(4) = 72.76$ ,  $p < 0.001$ ) and explains 39.2% of the variance in accuracy ( $R = 0.626$ ,  $R^2 = 0.392$ ). From these variables, 'Question type' had the largest effect on participant conformity. Participants were more likely to conform when presented with objective questions as compared to subjective questions. To ensure the validity of the model, we checked for the existence of multicollinearity. Our predictors report a variance inflation factor between 1.04 and 1.20, well below the often-used threshold of 5 to detect multicollinearity (Hair, Black, Babin, Anderson, & Tatham, 2010).

$$Y = -6.995 + 1.847X_1 + 0.060X_2 - 0.035X_3 + 0.017X_4 + 0.017X_5 \quad (1)$$

Table 1  
Effect of predictors on participant conformity.

	Estimate	SE	z value	Pr(> t )
(Intercept)	-6.995	1.019	-6.861	<0.001***
Question type (objective) ( $X_1$ )	1.847	0.296	6.251	<0.001***
Majority size ( $X_2$ )	0.060	0.009	6.441	<0.001***
Initial confidence ( $X_3$ )	-0.035	0.005	-7.412	<0.001***
Conscientiousness ( $X_4$ )	0.017	0.007	2.298	0.022*
Neuroticism ( $X_5$ )	0.017	0.007	2.294	0.022*

## 4.2. Feature description

Following model construction, we present a more detailed look at the significant features. We only considered the responses which placed participants in a minority, as the dependent variable was determining conformity behaviour. We observed that contextual determinants such as the nature of the question and the majority size significantly impact the likelihood of an individual conforming to the majority in online settings. Moreover, personal determinants such as initial confidence on the answer, neuroticism, and conscientiousness displayed significant influence on online social conformity.

### 4.2.1. Contextual determinants

The nature of the question (either objective or subjective) had the highest effect on whether an individual would conform to the majority or not. We observed that 83% (98 out of 118) of the conformity responses were related to objective questions while only 17% (20 out of 118) were associated with subjective questions. Moreover, we plotted the likelihood of each participant conforming to objective and subjective questions as illustrated in Fig. 4.

We note that the likelihood of participants conforming to objective questions ranged between 0%–67% with a median of 22%. However, the likelihood of participants conforming to subjective questions was considerably lower with a range of 0%–22% and a median value of 0%. Additional information on the interquartile range (IQR), mean values, and the standard deviation (SD) of the two distributions are given below the box plots seen in Fig. 4. In summary, the participants were more likely to accept the majority's judgement in objective questions when compared to subjective questions.

Majority size is another contextual predictor that displayed a significant relationship with the likelihood of a person conforming to the majority. Even though we included several other contextual predictors with regard to the group distribution such as the number of minorities and their corresponding sizes and the size difference between the participant's group and the majority group, none of these predictors displayed a significant impact on our dependent variable.

Fig. 5 illustrates an upward trend in conformity as the majority group size increases from 40%–90%, establishing that the likelihood

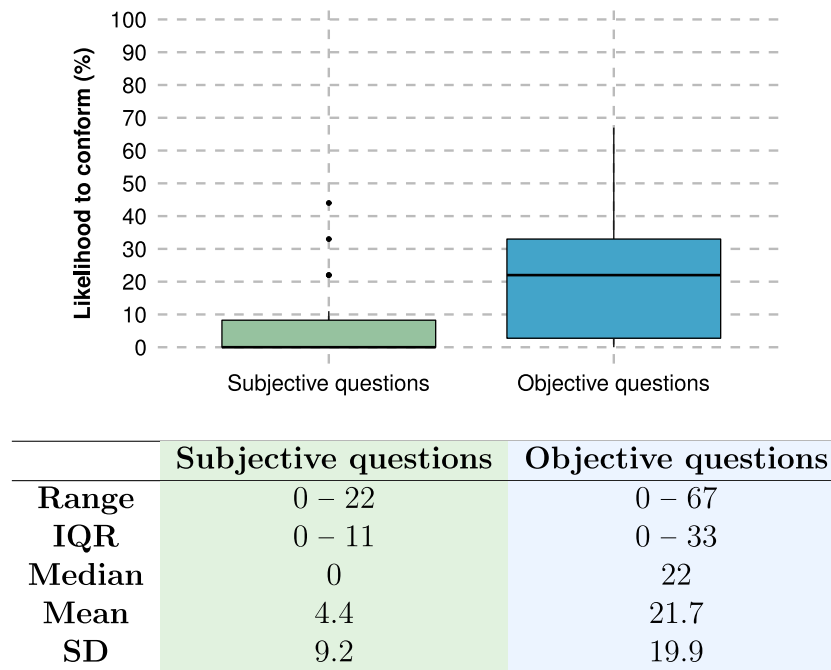


Fig. 4. The likelihood of user conformity across objective and subjective questions.

of an individual conforming to the majority's answer increases as the majority group increased in size. This observation is in line with the existing literature (Asch, 1955; Gerard et al., 1968; Stang, 1976a). We considered the original group size associated to the majority, before including the adjustment factor when plotting the figure. There was never a unanimous majority, as the feedback included the participant's selection as well. Moreover, as the number of group distributions that corresponded to each of the aforementioned majority group sizes varied, we defined likelihood of conformity as the proportion of conformity responses as a fraction of the total responses for each majority group size, for each participant.

However, it should be noted that the model also identified statistically significant main effects from several other factors such as question type, self-confidence, and personality traits of participants, which explain the outliers in Fig. 5. For example, for a given group composition half of the participants may have answered a subjective question, while the other half may have answered an objective question. Moreover, the model indicates that question type (either objective or subjective) had the largest effect on conformity behaviour.

#### 4.2.2. Personal determinants

The model established that the initial self-reported confidence level of participants has a negative correlation with the likelihood of them conforming to the majority's judgements. This notion is illustrated in Fig. 6 (a) in detail. The confidence levels of participants who conformed to the majority ranged between 0–100, with a median of 58. where as those who did not conform to the majority demonstrated a median value of 80 with a range of confidence values from 15–100. In general, individuals who displayed higher confidence on their personal answers were less likely to be impacted by the majority. The interquartile range (IQR), mean values, and standard deviation (SD) of the initial confidence values for non-conforming and conforming response distributions are provided below the box plots seen in Fig. 6 (a).

In addition to the aforementioned variables, the model also highlighted statistically significant relationships between personality traits such as conscientiousness (C) and neuroticism (N), and conformity behaviour. The other personality traits did not display statistically significant effects on conformity behaviour. The distribution of the

percentile values of the scores for C and N across conforming and non-conforming behaviour of participants is as illustrated in Fig. 6 (b) and (c) respectively. The corresponding statistics for the range, interquartile range (IQR), mean values, and standard deviation (SD) of the non-conforming and conforming response distributions are provided along with the box plots. For C, medians of 50 and 63 were observed from non-conforming and conforming responses respectively. Similarly for N, medians 50 and 64 were observed from non-conforming and conforming responses respectively. In summary, participants placed in higher percentiles for C and N were more susceptible to conformity. Moreover, we did not observe any significant gender differences in conformity behaviour of participants.

#### 4.3. Qualitative results

To better understand the factors leading to participant conformity and the use of our tool, we performed a qualitative analysis on the transcripts of the interviews. The individual interviews lasted for 10 to 15 min. Our semi-structured interview approach allowed participants to highlight elements which they considered important in addition to completing an identical set of questions among participants. Our questions focused on understanding the rationale behind a participant's urge to conform to the majority's judgements, as well as the usage of group feedback and the included bot. We discuss these topics in more detail below and provide exemplar citations from our participants.

##### 4.3.1. Support for contextual determinants of conformity

As indicated by our quantitative results, participants were more likely to conform to the majority opinion as the group size increased. Participants highlighted that larger majorities exerted more pressure to conform than smaller majorities; "I would follow the majority if it was more than 70%–80%. If it was 55% or 45%, I may be right. And I will insist on my answer." (P37). Moreover, participants mentioned that, even if they did not change their answer, a significant opposing majority led them to reconsider their initial answer; "When the majority was against me, in objective questions, it made me re-think and re-calculate. But when I was sure I moved on disregarding the majority." (P11).

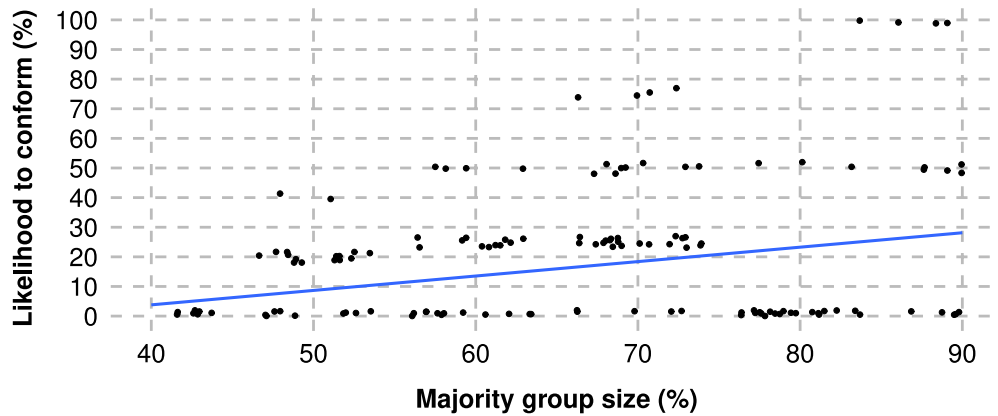


Fig. 5. The likelihood of conformity in participants as opposing majority size increases.

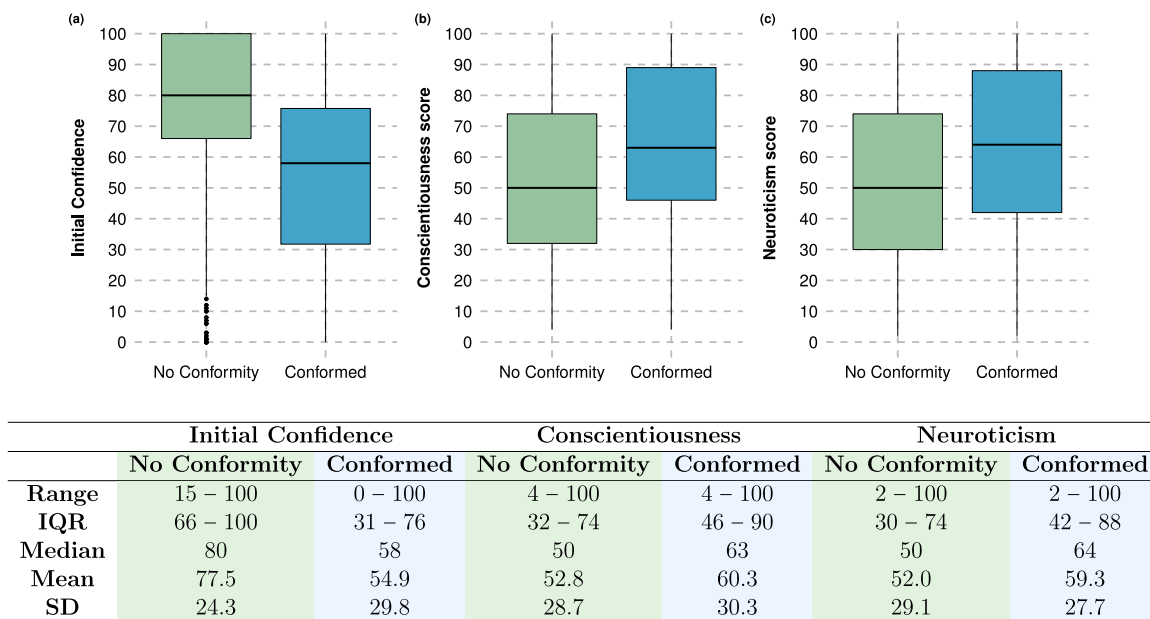


Fig. 6. (a) Initial confidence (b) Conscientiousness score (c) Neuroticism score of participants and their conformity behaviour.

Participants further indicated that they more frequently changed their answers for the objective questions, again confirming our quantitative results. This was motivated by the fact that it is possible for the participant’s answer to be incorrect for the objective questions. In the case of subjective questions participants felt less pressure to accept the opinions of the majority; “I went with the majority for objective questions thinking it was the right answer. I did not change in subjective questions. I can have my own opinion and did not have to agree with the majority.” (P31). A number of participants considered the feedback on interpreting subjective questions useful as it forced them to consider the viewpoint of the other parties. However, the analysis also suggested that anonymity and reduced social presence among group members, reduced the effects of ‘normative’ influences to a significant extent (especially with regard to subjective questions); “For subjective questions I will not change my answer or confidence no matter what. If it was a physical group, it would not be the case, I would want to be included and not stand out.” (P22).

4.3.2. Support for personal determinants of conformity

Not surprisingly, participants indicated that they conformed more when they were unsure about the correct answer to the question; “I looked at the feedback and thought [that] if the majority chose it, it could

be more correct. [...] When I was sure, I did not change.” (P44). In such situations, the majority’s judgements were perceived as an additional source of information; “For some questions when I did not know anything about the field, I chose the majority as I did not have any other source of information.” (P26). These observations confirms our quantitative results and suggest the significance of ‘informational’ influences exerted by the group majority on conformity.

4.3.3. Group feedback

Following submission of their initial answer, participants were presented with the feedback chart (i.e. the supposed answers of their peers). In general, participants reported that they were comfortable viewing the feedback; “I was very comfortable with the feedback coming for objective questions. It was like a cheat sheet with statistics. It was nice to see what how others answers.” (P19). Moreover, some participants highlighted that the distribution of answers were helpful in assessing their own answers and refocusing their thoughts; “If it was a math problem, you actually need to do the work and find the answer. If a lot of other people say otherwise, it [feedback] makes you reflect on your answer, which I think is good to confirm your understanding.” (P22).



#### 4.3.4. Chatbots

Participants were positive about the functionalities offered by the chatbot. In particular, participants highlighted its ability to structure the quiz and keep track of progress, as well as providing a general starting point for participants to ask questions; “*I liked the feeling of something automated accompanying me throughout quiz. In that quiet setting, doing this by myself, something is caring for me, it asks me if I need help.*” (P18). Even participants that did not actively use the bot were aware that the bot was there to support them when required; “*I ignored it. But I knew if I needed support, I could go to that chatbot.*” (P25).

When asked to compare instructions provided by a chatbot to those offered in a paper format, participants were predominantly in favour of the chatbot. Participants believed that interacting with a chatbot allows them to directly get the content they need, as the chatbot could narrow down the required information. Furthermore, participants enjoyed the interaction offered by the bot; “*[The chatbot] is more straightforward, convenient and you feel like you are talking to another person.*” (P07).

### 5. Discussion

Our results establish that online social conformity is determined by several contextual and personal determinants. We observed statistically significant relationships between majority group size, nature of the question, self-reported confidence, and certain personality traits on the likelihood of conforming behaviour.

#### 5.1. Factors affecting conformity

We observed that participants conformed more in objective questions as compared to subjective questions. This could also be attributed to the work of ‘informational’ influence. However, in the case of ‘normative’ influences, our findings contradict with previous work which observed higher conformity in subjective questions with a perceived socially ‘acceptable’ answer supported by the majority (Laporte et al., 2010). The impact of ‘normative’ influence was not prominently observed during our study. Rather, participants explained that the anonymity of the online setting encouraged them to support their judgements, especially in the case of subjective questions. On that note, it should be acknowledged that the cited study considered the impact of different levels of social presence among group members on their ‘normative’ behaviour, which was at a minimum in our study.

We note an upward trend in conforming behaviour as the majority increases in size. These observations are consistent with the literature (Asch, 1955; Latané & Wolf, 1981). However, it is noteworthy that our study did not merely employ unanimous majorities to influence conformity behaviour as was the case in previous work, but instead we investigated a broad spectrum of majority sizes. Furthermore, previous work has suggested that larger majorities exert higher ‘informational’ influence (Insko et al., 1985). Our qualitative analysis confirmed this hypothesis. Participants rationalised their conformity behaviour (especially in objective questions) as the ‘need to be right’ and emphasised that the answers provided by larger majorities were more plausible. As the majority grew in size, it was perceived unlikely to be wrong. Moreover, the presence of multiple minorities with varying group sizes had no significant impact on conformity.

During the quiz, participants reported their self-confidence on their answers. Participants who were unsure and less confident on their selections conformed more frequently to an opposing majority’s judgements. Based on this observation we infer that lower self-confidence on personal judgements amplifies the effects of ‘informational’ influences, and individuals who are less confident on personal judgements can easily be swayed towards that of the majority. This was also validated by our qualitative analysis where participants explained that when unsure of the chosen answer, the majority’s judgement appeared to be a more likely source of ‘right’ information. Similar observations were

made by Rosander and Eriksson (2012) where online conformity was more prominent as the self-reported difficulty of tasks increased.

Existing literature concerning personal traits and conformity suggests that higher anxiety could be a significant determinant of social conformity (Meunier & Rule, 1967; Rule & Sandilands, 1969). Our results confirm this premise, as we observed neuroticism scores of participants (which describes anxiety and emotional stability) to have a strong positive correlation with their conformity behaviour. This suggests that individuals who are less emotionally stable are more susceptible to conformity influences. Moreover, a similar relationship was observed between conscientiousness scores (which describes goal-orientation and diligence) and conformity. Such goal-oriented behaviour may encourage an individual to obtain the ‘correct’ answer at any cost. Individuals with high conscientiousness may doubt their answers when facing a contradicting majority and accept the majority’s judgement to be more accurate than their own perception of the same situation. This behaviour is likely to be encouraged by ‘informational’ influences at play.

Furthermore, literature on face-to-face conformity highlights gender differences in conformity behaviour, driven by stereotypical masculine and feminine social roles imposed by society (Eagly & Wood, 1985). However, our results contradict this notion as we do not observe statistically significant differences in conformity amongst men and women. We emphasise that the online setup used for this study lacks the social presence introduced in typical face-to-face group settings, which may have reduced the influence of the aforementioned gender stereotypical social roles on the observed conformity behaviour of our participants.

#### 5.2. Online social conformity

In general, the results of this study strongly indicate that online social conformity is a function of multiple contextual and personal determinants. While the inherent dissimilarities between face-to-face and online groups (such as anonymity and reduced social presence in the latter), may have reduced the effects of ‘normative’ influences, ‘informational’ influences are still predominantly apparent in online settings. This study showed that the ‘need to be right’ displayed strong associations with all the aforementioned predictors. Thus, our results suggest that online settings with static and unidirectional communication is sufficient to elicit conformity behaviour mainly influenced by ‘informational influences’ (rather than ‘normative influences’), and that by regulating the determinants it may be possible to reduce the impact of ‘informational’ influences on social conformity.

Moreover, in our qualitative analysis we observed that participants generally preferred receiving feedback from peers and perceived it as a tool of learning and reasoning. This observation follows London and Sessa (2006) and Van Popta, Kral, Camp, Martens, and Simons (2017), that explain the advantages of peer feedback in group settings. Thus, completely eliminating the use of feedback may not be the best approach to avoid conformity. Further work is required to identify online environments where conformity possesses a higher risk and employ methods that can mitigate its adverse impacts. Such methods could vary from simple design adjustments in online communities (Sukumaran et al., 2011) to more complex techniques that reduce the anticipated impact of the contextual (e.g., anonymity, use of visual cues, diversity, group size) and personal (e.g., self-confidence, personality differences) determinants of social conformity.

Finally, the use of a chatbot for training and support during the quiz was seen as beneficial, as a significant number of participants preferred instructions coming from an interactive bot over static on-screen instructions, which is in line with related literature (van der Meij, 2013). It also enabled us to simulate a more realistic online environment where participants understood the instructions and familiarised themselves with the setting, minimising any influence by the researcher (i.e. Hawthorne Effect (Adair, 1984)), a crucial aspect when investigating social conformity. Furthermore, our participants perceived the chatbot

as a readily available source of support and feedback in an isolated setting. Similar observations were made by Pereira (2016) and Bickmore, Pfeifer, and Paasche-Orlow (2009). Some participants also mentioned that even the simple interpretations given by the bot regarding the feedback charts assisted them in reasoning and decision making as previously established in Le and Wartschinski (2018).

### 5.3. Limitations

There were several limitations in our study. Even though our participants came from diverse backgrounds, they represented a relatively young population with adequate digital experience. This may have indirectly discouraged 'normative' social influences. Furthermore, we did not investigate aspects of online social interactions beyond anonymity in the current study. We note that future work could look into the effects of different levels of social presence and the use of social context cues (e.g., names, avatars) in online settings and their effect on conformity behaviour. Moreover, to exclude confounding variables such as participant assertiveness, we deployed our study in a controlled environment (one participants at a time). We aim to explore the effect of simultaneous interactions in an online setting in future work. Future research could also explore the effect of the identified contextual and personal determinants on the quality of output generated by online groups.

## 6. Conclusion

Social conformity is a widely experienced form of social influence, both in face-to-face and online groups, where minorities change their behaviour and opinions to match contrasting opinions of the group majority. While determinants of conformity has been studied in face-to-face groups, it is yet to be thoroughly explored in online group settings. Thus, this work aimed to study both contextual and personal determinants of social conformity and their implications in online environments.

Our results establish that larger majority group sizes have a bigger effect on conformity behaviour. Participants conformed more frequently for objective questions demonstrating high levels of 'informational' influences. Moreover, participants who reported low self-confidence, demonstrated high conscientiousness, or had high levels of neuroticism commonly conformed to the majority. We observed no significant effects rising from the number of minorities or minority group sizes. Moreover, no strong gender differences were observed with regard to conformity behaviour.

Our observations concerning majority group sizes, self-reported confidence, and personality traits are in line with existing literature related to 'informational' influences of conformity. However, with regard to the nature of questions our work presents contrasting findings to those in the literature. Our qualitative analysis suggests that this difference in behaviour may be due to lower levels of 'normative' influences in an online setting as opposed to physical groups.

Our work set forth several avenues for further work. We intentionally utilised anonymous peers to suit the research objectives explored in this study. However, further work could investigate online social conformity when peers are identifiable through realistic cues (such as first names, usernames and avatars). Such factors could trigger stereotypical behaviour with regard to gender and age which could enhance or diminish conformity influences. Moreover, the cues themselves may differ from one another based on the amount of influence they exert. This would be a potential step forward in understanding factors of social conformity in realistic online settings.

### 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.

## References

- Adair, J. G. (1984). The Hawthorne effect: a reconsideration of the methodological artifact. *Journal of Applied Psychology*, 69(2), 334–345.
- Adrianson, L. (2001). Gender and computer-mediated communication: Group processes in problem solving. *Computers in Human Behavior*, 17(1), 71–94.
- Asch, S. E. (1951). Effects of group pressure upon the modification and distortion of judgements. In *Groups, leadership and men* (pp. 177–190). Oxford, England: Carnegie Press.
- Asch, S. E. (1955). Opinions and social pressure. *Scientific American*, 193(5), 31–35.
- Asch, S. E. (1956). Studies of independence and conformity: A minority of one against a unanimous majority. *Psychological Monographs: General and Applied*, 70(9), 1–70.
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67(1), 1–48.
- Beran, T., Drefs, M., Kaba, A., Al Baz, N., & Al Harbi, N. (2015). Conformity of responses among graduate students in an online environment. *The Internet and Higher Education*, 25, 63–69.
- Bickmore, T. W., Pfeifer, L. M., & Paasche-Orlow, M. K. (2009). Using computer agents to explain medical documents to patients with low health literacy. *Patient Education and Counseling*, 75(3), 315–320.
- Blake, R. R., Helson, H., & Mouton, J. S. (1957). The generality of conformity behavior as a function of factual anchorage. Difficulty of task, and amount of social pressure. *Journal of Personality*, 25(3), 294–305.
- Bolker, B. M., Brooks, M. E., Clark, C. J., Geange, S. W., Poulsen, J. R., Stevens, M. H. H., et al. (2009). Generalized linear mixed models: a practical guide for ecology and evolution. *Trends in Ecology and Evolution*, 24(3), 127–135.
- Bond, R. (2005). Group size and conformity. *Group Processes & Intergroup Relations*, 8(4), 331–354.
- Cialdini, R. B., & Goldstein, N. J. (2004). Social influence: Compliance and conformity. *Annual Review of Psychology*, 55, 591–621.
- Cinnirella, M., & Green, B. (2007). Does 'cyber-conformity' vary cross-culturally? Exploring the effect of culture and communication medium on social conformity. *Computers in Human Behavior*, 23(4), 2011–2025.
- Coleman, J. F., Blake, R. R., & Mouton, J. S. (1958). Task difficulty and conformity pressures. *The Journal of Abnormal and Social Psychology*, 57(1), 120–122.
- Crutchfield, R. S. (1955). Conformity and character. *American Psychologist*, 10(5), 191.
- Deutsch, M., & Gerard, H. B. (1955). A study of normative and informational social influences upon individual judgment. *The Journal of Abnormal and Social Psychology*, 51(3), 629–636.
- Eagly, A. H. (1983). Gender and social influence: A social psychological analysis. *American Psychologist*, 38(9), 971–981.
- Eagly, A. H., & Chivala, C. (1986). Sex differences in conformity: Status and gender role interpretations. *Psychology of Women Quarterly*, 10(3), 203–220.
- Eagly, A. H., & Wood, W. (1985). Gender and influenceability: Stereotype versus behavior. In *Women, gender, and social psychology* (pp. 225–256). Hillsdale, NJ, USA: Erlbaum.
- Endler, N. S. (1961). Conformity analyzed and related to personality. *The Journal of Social Psychology*, 53(2), 271–283.
- Ferguson, L. W. (1944). An analysis of the generality of suggestibility to group opinion. *Journal of Personality*, 12(3), 237–243.
- Gerard, H. B., Wilhelmy, R. A., & Conolley, E. S. (1968). Conformity and group size. *Journal of Personality and Social Psychology*, 8(1), 79–82.
- Goncalves, J., Kostakos, V., & Venkatanathan, J. (2013). Narrowcasting in social media: Effects and perceptions. In *Proceedings of the 2013 IEEE/ACM international conference on advances in social networks analysis and mining* (pp. 502–509).
- Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. (2010). *Multivariate data analysis*. New Jersey, NJ, USA: Pearson.
- Insko, C. A., Smith, R. H., Alicke, M. D., Wade, J., & Taylor, S. (1985). Conformity and group size: The concern with being right and the concern with being liked. *Personality and Social Psychology Bulletin*, 11(1), 41–50.
- John, O. P., & Srivastava, S. (1999). The big five trait taxonomy: History, measurement, and theoretical perspectives. *Handbook of Personality: Theory and Research*, 2(1999), 102–138.
- Kaplan, M. F., & Miller, C. E. (1987). Group decision making and normative versus informational influence: effects of type of issue and assigned decision rule. *Journal of Personality and Social Psychology*, 53(2), 306–313.
- Laporte, L., van Nimwegen, C., & Uytendaele, A. J. (2010). Do people say what they think: Social conformity behavior in varying degrees of online social presence. In *Proceedings of the 6th nordic conference on human-computer interaction: Extending boundaries* (pp. 305–314). New York, NY, USA: ACM.
- Latané, B., & Wolf, S. (1981). The social impact of majorities and minorities. *Psychological Review*, 88(5), 438–453.
- Le, N. T., & Wartschinski, L. (2018). A cognitive assistant for improving human reasoning skills. *International Journal of Human-Computer Studies*, 117, 45–54.
- Levine, J. M. (1999). Solomon Asch's legacy for group research. *Personality and Social Psychology Review*, 3(4), 358–364.
- Liu, Y., Venkatanathan, J., Goncalves, J., Karapanos, E., & Kostakos, V. (2014). Modeling what friendship patterns on facebook reveal about personality and social capital. *ACM Transactions on Computer Human Interaction*, 21(3), 17:1–17:20.

- London, M., & Sessa, V. I. (2006). Group feedback for continuous learning. *Human Resource Development Review*, 5(3), 303–329.
- Lowry, P. B., Roberts, T. L., Romano Jr, N. C., Cheney, P. D., & Hightower, R. T. (2006). The impact of group size and social presence on small-group communication: Does computer-mediated communication make a difference? *Small Group Research*, 37(6), 631–661.
- Mausner, B. (1954). The effect of prior reinforcement on the interaction of observer pairs. *The Journal of Abnormal and Social Psychology*, 49(1), 65–68.
- Mausner, B., & Bloch, B. L. (1957). A study of the additivity of variables affecting social interaction. *The Journal of Abnormal and Social Psychology*, 54(2), 250–256.
- McKenna, K. Y., & Green, A. S. (2002). Virtual group dynamics. *Group Dynamics: Theory, Research, and Practice*, 6(1), 116–127.
- Meunier, C., & Rule, B. G. (1967). Anxiety, confidence, and conformity. *Journal of Personality*, 35(3), 498–504.
- Pereira, J. (2016). Leveraging chatbots to improve self-guided learning through conversational quizzes. In *Proceedings of the fourth international conference on technological ecosystems for enhancing multiculturalism* (pp. 911–918). ACM.
- Reynolds, B., Venkatanathan, J., Goncalves, J., & Kostakos, V. (2011). Sharing ephemeral information in online social networks: Privacy perceptions and behaviours. In *Proceedings of the IFIP conference on human-computer interaction – INTERACT 2011* (pp. 204–215).
- Rosander, M., & Eriksson, O. (2012). Conformity on the internet—the role of task difficulty and gender differences. *Computers in Human Behavior*, 28(5), 1587–1595.
- Rosenberg, L. A. (1963). Conformity as a function of confidence in self and confidence in partner. *Human Relations*, 16(2), 131–139.
- Rule, B. G., & Sandilands, M. L. (1969). Test anxiety, confidence, commitment, and conformity. *Journal of Personality*, 37(3), 460–467.
- Samelson, F. (1957). Conforming behavior under two conditions of conflict in the cognitive field. *The Journal of Abnormal and Social Psychology*, 55(2), 181–187.
- Sharma, E., & De Choudhury, M. (2018). Mental health support and its relationship to linguistic accommodation in online communities. In *Proceedings of the 2018 CHI conference on human factors in computing systems* (pp. 641:1–641:13). New York, NY, USA: ACM.
- Smilowitz, M., Compton, D. C., & Flint, L. (1988). The effects of computer mediated communication on an individual's judgment: A study based on the methods of Asch's social influence experiment. *Computers in Human Behavior*, 4(4), 311–321.
- Stang, D. J. (1976a). Group size effects on conformity. *Journal of Social Psychology*, 98(2), 175–181.
- Stang, D. J. (1976b). Ineffective deception in conformity research: Some causes and consequences. *European Journal of Social Psychology*, 6(3), 353–367.
- Sukumaran, A., Vezich, S., McHugh, M., & Nass, C. (2011). Normative influences on thoughtful online participation. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 3401–3410). New York, NY, USA: ACM.
- van der Meij, H. (2013). Motivating agents in software tutorials. *Computers in Human Behavior*, 29(3), 845–857.
- Van Popta, E., Kral, M., Camp, G., Martens, R. L., & Simons, P. R.-J. (2017). Exploring the value of peer feedback in online learning for the provider. *Educational Research Review*, 20, 24–34.
- Venkatanathan, J., Karapanos, E., Kostakos, V., & Goncalves, J. (2012). Network, personality and social capital. In *Proceedings of the 4th annual ACM web science conference* (pp. 326–329). ACM.