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A cross-cultural EEG study of how obedience and conformity influence reconciliation intentions

Guillaume P. Pech[1], Emilie A. Caspar[2,*]

[1]Center for Research in Cognition and Neuroscience, Université libre de Bruxelles, Brussels, 1050 Belgium
[2]Moral & Social Brain Lab, Department of Experimental Psychology, Center for Cognitive Neuroscience, Ghent University, Ghent, 9000 Belgium
[*]Corresponding author. Department of Experimental Psychology, Ghent University, Henri Dunantlaan, 2, Ghent 9000, Belgium, E-mail: Emilie.Caspar@UGent.be

Abstract

The study investigated the influence of conformity and obedience on intentions to help a child whose relative had caused harm to the participant's family during historical events of violence. Participants from Belgium, Cambodia, and Rwanda faced different social scenarios with two types of social influence and had to choose whether to respond helpfully. A multi-method and cross-cultural approach combining self-reports, behaviours, decision times (DTs), and electroencephalography (EEG) data was used. Participants explicitly reported being more influenced by authority (obedience) than by a group (conformity), a finding supported by faster DTs when following authority recommendations compared to either a group or an individual alone (compliance). However, behavioural and neural data showed no distinction between obedience and conformity. Behaviourally, authority and group influences exceeded individual influence but did not differ significantly. EEG results revealed higher mid-frontal theta (FMθ) activity for both the authority and the group indicating stronger inhibition of alternative choices compared to individual compliance. These results suggest that the type of measurement impacts the observed influence of authority and conformity, thus posing interesting questions regarding what may influence real behaviours. Variations were observed between countries, highlighting the importance of accounting for cross-cultural differences and avoiding generalization from a single population sample.

Keywords: social influence; obedience; conformism; prosocial intentions; reconciliation; cross-cultural

Introduction

The history of humanity has been, and still is, fraught with conflict, which, in a cycle, can lead to further conflicts, particularly from new generations driven by a desire for revenge (Lumsden 1997). A deeper understanding of conflict mechanisms could shed light on this persistent challenge faced by humankind. Prosociality emerges as a key mechanism that aids in achieving reconciliation (Nadler and Shnabel 2015, Mironova and Whitt 2016) and prevents future conflicts (Ostrom 2000, Fehr and Fischbacher 2004). This capacity is inherent among humans and encompasses a wide array of actions, including aiding others, allocating time or resources, registering as an organ donor, or offering comfort to others (Batson and Powell 2003, Pavey et al. 2011, Van Tongeren et al. 2016). Conformity and obedience are two leverages that could be used to make people adopt better prosocial attitudes in various contexts (Cialdini and Goldstein 2004, Pascual et al. 2014, Korn et al. 2020). However, the respective role of obedience and conformity in promoting reconciliation and the associated mechanisms remains largely under-investigated.

The literature frequently refers to conformity and obedience as key forms of social influence on decision-making (Tricoche and Caspar 2024). Conformity has been described as the process by which individuals adjust their attitudes, beliefs, or behaviours to align with a group of peers, while obedience refers to a situation where individuals follow direct instructions or orders from an authority figure (David and Turner 2001). The study of obedience was revolutionized by Stanley Milgram, whose experiments demonstrated how obedience could lead to antisocial behaviours, such as physically harming another person (Milgram 1963, 1974). Many subsequent works also focusing on antisocial behaviours followed, such as the Utrecht studies (Meeus and Raaijmakers 1995), the virtual avatar (Slater et al. 2006), the 150-wolt method (Burger 2009), obedience in a TV show (Beauvois et al. 2012), obedience to hurt an animal (Bègue and Vezirian 2022), or inflicting real shocks to another person in exchange for a small monetary reward (Caspar 2021, Caspar et al. 2022a). All these studies showed converging evidence that obedience to authority can strongly alter moral behaviours by increasing hurtful behaviours towards others, but a few other studies interestingly suggested that obedience could also be used to enhance prosocial behaviours (Kärtner et al. 2010, Pascual et al. 2014). The study of conformity was put forward by Solomon Asch's line judgment

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experiments, where participants were swayed by group pressure to ignore clear evidence and agree with incorrect answers (Asch 1951). Subsequent research has further shown that a group can influence ratings and opinions (Klucharev et al. 2009, Berns et al. 2010), not only prosocial behaviours (Pascual et al. 2014, Agerström et al. 2016), but also unwanted behaviours (Baumeister et al. 2016), such as abstaining in elections (Levine and Palfrey 2007), groupthink (Turner and Pratkanis 1998), social loafing (Simms and Nichols 2014), or inaction in emergency situations, a phenomenon known as the bystander effect (Darley and Latane 1968). In the present study, we studied the extent to which conformism and obedience can have similar effect on prosocial intentions and related moral mechanisms, with conformism being represented by a group of peers and obedience being represented by a single authority figure. We also introduced a third form of social influence, namely compliance, as a control condition. Compliance is commonly defined as acquiescing to a request, even when the request does not come from an authority figure, but for instance from a peer (Oc and Bashshur 2013). Here, compliance was thus represented by a single peer individual, which was expected as influencing less the decisions of the participants compared to conformism and obedience. Experimental work is scare, but a recent study suggested that compliance induce less conflict before decisions than obeying an authority figure (Götz et al. 2023).

Comparative behavioural work between these different forms of social influence is scare, but the few existing studies tend to suggest that obedience could have a greater effect on human behaviours than conformity. For instance, qualitative interviews with former genocide perpetrators in Rwanda showed that obedience to authority was more frequently reported (about 70%) compared to the influence of the group (about 20%) in order to explain their participation (Caspar 2024b). A behavioural study showed that placing signs prompting people to put the cigarette butts in an ashtray reduced the number of cigarettes thrown, but that placing those signs nearby a location associated with authority, such as the municipality (i.e. obedience), compared to a supermarket (i.e. conformity) reduced even more the number of cigarettes thrown on the ground (Pascual et al. 2014). Another study in a clinical setting also showed that 65% of their sample composed of midwives follow directions from a senior person (i.e. obedience), compared to 35% who rather followed opinions (i.e. conformity) (Martin and Bull 2008). However, another study showed no statistical difference at the behavioural level between conformity and obedience on online book purchasing (Xie et al. 2016).

Regarding the mechanisms of social influence, Bandura's work suggested that changes in behaviour may emerge because individuals in groups or those following an authority figure act as if they have diffused responsibility (in the case of conformity) or displaced responsibility (in the case of obedience) to others (Bandura et al. 1975, Bandura 2016). More recent literature in neuroscience has shown that multiple mechanisms are at play to explain how obedience and conformity influences behaviours and attitudes, occurring at different phases during the decision-making process. First, the brain must process information from the surrounding environment (i.e. predecisional phase), then it must decide which actions to perform and send the command to the muscles (i.e. decision and action phase), and finally evaluate the outcomes (i.e. postdecisional phase) (Tricoche and Caspar 2024). In the literature on obedience using electroencephalography (EEG) and functional Magnetic Resonance Imagery (fMRI) data, it has been shown that obeying orders to inflict harm to another person, compared to perform the same action but freely, impacts negatively different neuro-cognitive processes in the action and decision phase, with notably moral conflict (mid-frontal theta EEG activity) (Caspar and Pech 2024), the sense of agency [temporal binding (Haggard et al. 2002)] and the feeling of responsibility (measured through explicit questions) (Caspar et al. 2016, 2017, 2018, 2020b, Akyüz et al. 2024). Obeying orders also impacts the postdecisional phase, influencing empathy for pain (measured by ERPs such as the P3 and LPP, and BOLD signal in the pain network) (Caspar et al. 2020a, 2022b, Pech and Caspar 2023), and the BOLD signal associated with the interpersonal feeling of guilt (Caspar et al. 2020a). In the literature on conformity, it has been shown that participants playing with another player exhibit a reduced explicit sense of agency (i.e. the decision and action phase) as well as a reduced ERP amplitude of the feedback-related negativity associated with the negative outcomes following their action (i.e. postdecisional phase) (Beyer et al. 2017). Conformity for harmful behaviours has also been found to be stronger than for nonharmful behaviours, and that several processes such as empathy (P3 and LPP) and agency (temporal binding) are impacted by peer conformity (Piperno et al. 2025). Another study also found that conformity was linked to functional changes in the occipital–parietal network during the predecisional phase of a mental rotation task under peer pressure (Berns et al. 2005).

Interestingly and in complement to most of the behavioural research, comparative work in neuroscience suggest that the influence of an authority figure has a greater impact on neural processing than group influence does. In a study using magnetoencephalography (MEG), participants performed a gambling task in various social contexts alone, together with other players, or in a forced condition where another person decided on behalf of the participant (El Zein et al. 2022). Overall, results showed that groups reduce responsibility and the neural processing of action's outcome, but that having someone deciding for you how to act alter even more such processes. Another study tends to confirm such conclusions (Xie et al. 2016). Participants had to make quick decisions to buy a book based on basic data and majority feedback or were directed to choose books with negative reviews. EEG results showed greater stimulus-locked cognitive conflict, as measured by the N2 amplitude, in obedience-driven choices than in conformity-based ones, suggesting that obedience arouses greater cognitive conflict than conformity. The number of studies that have conducted comparative work remains however limited and hinders strong conclusions. Additionally, none of these comparative studies in neuroscience focused on prosocial behaviours or intentions, nor did they involve cross-cultural comparisons to increase the generalizability of their findings.

In the present study, we used a fictional task of intended prosociality (Pech and Caspar 2022, Pech et al. 2023), reflected by helpful or unhelpful intentions, towards the child of someone who had hurt one's own family in the past. Participants were presented with different scenarios and then influenced by two forms of social influence (e.g. a group of peers for conformity vs. an authority figure for obedience) to choose the helpful or the unhelpful behaviours. An individual presented alone was also included as a control form of social influence, representing compliance. We measured participants' intention to engage or not in helpful behaviours, as well as decision times (DT) and response-locked mid-frontal theta activity (FMθ) as indices of cognitive conflict (Cavanagh and Frank 2014; Cohen and Donner 2013), similarly to previous studies (Pech and Caspar 2022, Pech et al. 2023). Cognitive conflict occurs when incongruent or competing information challenges the brain's processing mechanisms, requiring additional cognitive resources to resolve the discrepancy (Cohen 2014), and can therefore be used to measure how difficult a decision is. Previous research has shown that decisions that are difficult to make are associated with longer reaction times (RTs ; Greene et al. 2004, Cohen and Donner 2013) and higher midfrontal theta (FMθ) activity [4–8 Hz (Cavanagh and Frank 2014; Cohen and Cavanagh 2011, Nigbur et al. 2012)] compared to easier decisions. In source-localization studies, FMθ has been associated with the activity of the Anterior Cingulate Cortex (ACC), which has also been linked to cognitive conflict (Asada et al. 1999). FMθ activity can thus be interpreted as reflecting cognitive demand prior to decision making. Specifically, the literature has shown that choices that elicit more conflict require greater cognitive resources, leading to increased FMθ activity (Cavanagh and Frank 2014, Pech et al. 2023). In studies assessing moral or social decisions, lower FMθ activity before a prosocial action has notably been linked to enhanced prosociality (Amodio et al. 2008, Pech and Caspar 2022, Caspar and Pech 2024). However, dissociations have also been observed between behavioural data, DTs, and neural data in social decision-making (Pech et al. 2023), supporting the need for including these different levels of measurement.

Based on the literature mentioned above, our first general hypothesis (Hypothesis 1) is that obedience exerts a stronger influence on helpful intentions, as indicated by greater behavioural alignment with the authority figure compared to other forms of social influence. Hypothesis 1 also predicts that decisions to follow an authority figure are easier, as reflected by lower DTs and reduced frontal midline theta activity (FMθ) prior to the action, compared to decisions driven by conformity or compliance. Our second hypothesis (Hypothesis 2) is that such results may vary across cultures. To the best of our knowledge, cross-cultural variations in this context have not been thoroughly investigated, making clear predictions difficult. It has been shown that nations in close proximity tend to exhibit significant overlap in various cultural aspects (Green et al. 2005). Therefore, we conducted the present study in three geographically and continentally dispersed countries: Belgium, Rwanda, and Cambodia. The two existing neuroscience studies that directly compared obedience and conformity on behaviours showed convergent results between a sample recruited in Germany (El Zein et al. 2022) and a sample recruited in China (Xie et al. 2016). These findings suggest that for Hypothesis 2, no cultural variations and a similar influence of obedience and conformity might be observed in the present study. However, other studies have shown that collectivist cultures are more influenced by others than individualistic cultures (Triandis 2001, Oyserman et al. 2002), it has been suggested that countries relying on a more bureaucratic system are more likely to promote antisocial behaviours under obedience (Kelman and Hamilton 1989). These elements could lead to differences between our target countries. Furthermore, another study comparing obedience to authority between Rwandans tested in Rwanda and Rwandans tested in Belgium observed higher rates of disobedience in the latter linked to a lower adherence to authority and greater neural attention to the experimenter's instructions (Caspar et al. 2022a). These findings highlight the possibility of cultural differences influencing prosociality under social influence. Therefore, the impact of culture on prosociality under social influence remains a bidirectional hypothesis.

Methods

Participants

The task and its hypotheses were preregistered (https://osf.io/2xrfg/). In the preregistrations, the present task corresponds to Study 2. Study 1 was not completed because, during the pilot studies, participants reported confusion between processing the 'yes' and 'no' displayed on the screen and the 'yes' and 'no' they had to decide on, whereas the experimental paradigm in Study 2 was clearer. As reported in the preregistrations, an a priori power calculation with G*Power indicated that for a medium effect size f of 0.25 and a power of 95%, we needed to recruit 24 participants per country with a repeated-measure ANOVA. However, due to constraint of time and recruitment, the number of participants was lower in Cambodia. To ensure reliable conclusions, we thus decided to deviate from the preregistered ANOVA and use Bayesian hierarchical model instead to increase power (Brown 2021), as well as to report the conclusiveness of the results (Dienes 2014). Seventy-eight participants were recruited across Belgium ($N = 30$, 24 females), Cambodia ($N = 20$, 11 females) and Rwanda ($N = 28$, 17 females). The mean age was 21.6 (SD = 4.2) for the group in Belgium, 20.1 (SD = 4.8) for the group in Cambodia, and 22.9 (SD = 1.1) for the group in Rwanda. In each country, we recruited participants studying at the university not only to control for the educational level, but also to have a relatively similar testing environment. The following exclusion criteria were determined prior to further analysis: (I) failure to understand the task, and (II) failure to obtain good signal-to-noise ratio for EEG recordings. Classic reasons to fail to obtain a good signal-to-noise ratio involve head movement artefacts or sweat artefacts.

We sought to obtain the approval of local institutions in each country. Informed consent, provided in the native language of all participants (i.e. Khmer, Kinyarwanda, French) was obtained from all participants with a method approved by the three ethics committees, ensuring that any potential cultural differences for giving a consent would be considered. In Belgium, the study was approved by the local ethical committee of the Université libre de Bruxelles (reference: 1002/2023). In Rwanda, the study was approved by the Rwandan National Ethics Committee (reference: 167/RNEC/2021). In Cambodia, the study was approval by the National University of Battambang (reference: 0063/22). All participants received monetary compensation based on the average cost of living in each country.

Method and procedure

The study took place in three different countries: Belgium, Cambodia, and Rwanda. We tried to ensure the most similar testing conditions and procedures in the three countries to ensure comparisons. Upon arrival in one of the rooms at the university and after signing consent, volunteers were placed in front of a computer with a 2-button keyboard in front of them. A 32-channel EEG Biosemi system was placed before starting the training. The EEG and the computers were the same across the three countries to avoid an effect of material. They were transported by diplomatic bags over a 9-month period.

We used a task that was previously successfully implemented in Belgium (Pech and Caspar 2022) and in Rwanda (Pech et al. 2023) to assess prosocial decision-making in a fictional task, but we adapted it to require participants to choose the form of social influence they would prefer to follow. First, participants were presented with the three forms of social influence on the screen presented one by one, with what they represent being written below (e.g. the word 'authority' was placed below the figure of the authority, in the language of each participant). This phase was conducted to ensure that participants correctly associated the forms of social influence with the visual display of the individuals presented on the screen. The authority figure was represented by a single person dressed in a formal black suit, the individual was

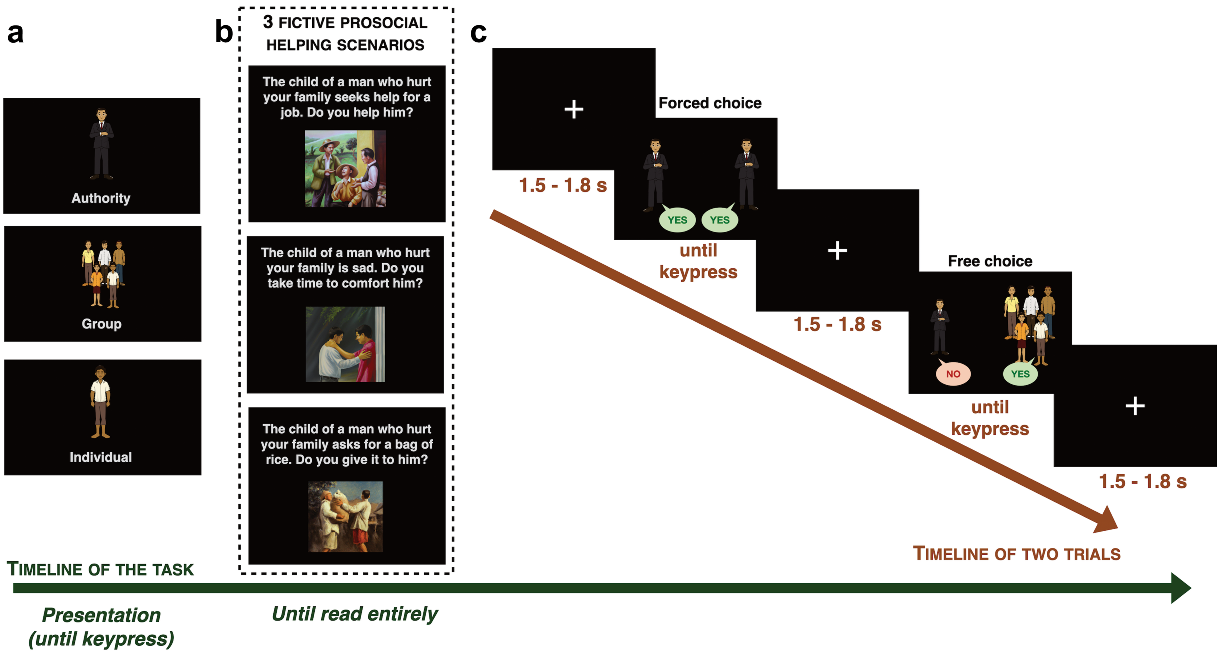

Figure 1. (a) The three forms of social influence (i.e. authority, group, and compliance) were presented in the native language of participants. (b) One scenario was then presented in the native language of participants. (c) Volunteers were then presented with the different combinations of stimuli, with a jittered fixation cross lasting between 1.5 and 1.8 s between each presentation. Participants were instructed to press either the left or right arrow key on the keyboard as quickly as possible to indicate their decision.

represented as a person alone and dress casually, and the group was composed of five different individuals dressed casually (see Fig. 1a). Importantly, stimuli were cartoon-like, to reduce possible effect of identification with the persons on the picture. Also, each stimulus was adapted to the country, with the skin color and types of clothing. To control for gender, only male individuals were displayed in the pictures in all countries.

When participants finished to look at the three forms of social influence, they were asked to press a key on the keyboard to begin the task. They were then presented with three different prosocial scenarios that could reflect real acts of helpful behaviours, again in the main language of the volunteers (i.e. French in Belgium, Khmer in Cambodia, and Kinyarwanda in Rwanda; see Fig. 1b). These scenarios were based on the three main types of prosocial behaviours, which are helping, sharing, and comforting (Wu and Hong 2022). Participants were asked to imagine themselves in those scenarios and decide, as they would in real life, whom they would take time to comfort, whom they would help find a job, or with whom they would share food. While not targeting the child of someone who hurt one's family in the past, those scenarios were previously used in Rwanda (Pech et al. 2023) and Belgium (Pech and Caspar 2022) and were considered reliable for assessing prosociality in both rural and urban citizens. In Rwanda, the word 'reconciliation' has a strong connotation in the postgenocidal context and is often used by official instances for promotion. To avoid any linkages with official instances, we assessed reconciliation intentions more indirectly by never mentioning the word itself. More precisely, each scenario specifically involved being helpful to the child of a man who had hurt their family in the past. To aid volunteers in understanding the scenarios, a relevant picture linked to the scenario was systematically displayed (e.g. a picture of two persons hugging for the scenario involving comforting someone). Participants were instructed to press a key on the keyboard once they finished reading or listening to the scenario.

After the scenario presentation, the trial began with a jittered fixation cross lasting between 1.5 and 1.8 s. Six combinations of stimuli were then presented by pairs (see Fig. 1c), asking volunteers either to choose 'Yes' (i.e. the helpful intention) or 'No' (i.e. the unhelpful intention), and also to choose to follow the 'Authority', the 'Group', or the 'Individual'. The pairs consisted of either the same stimulus presented twice (i.e. forced-choice condition) or a pair with different stimuli (i.e. free-choice condition). Since participants had complete freedom in the free-choice condition, there was a possibility of a lack of data towards one of the stimuli if never selected. The forced-choice condition was introduced to ensure an adequate number of trials and measurements for all individuals, similar to Pech et al. (2023). Naefgen and colleagues indeed found that reaction time in free-choice decisions involves additional processes compared to forced-choice decisions (Naefgen et al. 2018). This increased complexity may introduce more biases in the interpretation of cognitive conflict for free-choice decisions compared to forced-choice decisions.

Participants were instructed to press either the left or right arrow key on the keyboard as quickly as possible to indicate who they follow and which intention they report (i.e. yes or no). Once the different pairs of stimuli were randomly presented, another scenario appeared on the screen, and the same procedure was repeated. Each scenario was presented six times in a pseudo-randomized order, to avoid two same consecutive scenarios. Each presentation of scenario was followed by 18 pairs of stimuli (i.e. one of each). The pairs of stimuli consisted of six forced-choice as follows: (i) Authority-Yes vs. Authority-Yes, (ii) Authority-No vs. Authority-No, (iii) Group-Yes vs. Group-Yes, (iv) Group-No vs. Group-No, (v) Individual-Yes vs. Individual-Yes, and (vi) Individual-No vs. Individual-No; and 12 free-choice possibilities, as follows: (i) Authority-Yes vs. Group-Yes, (ii) Authority-Yes vs. Group-No, (iii) Authority-Yes vs. Individual-Yes (iv) Authority-Yes vs. Individual-No (v) Authority-No vs. Group-Yes, (vi) Authority-No vs. Group-No, (vii) Authority-No vs. Individual-Yes (viii) Authority-No vs. Individual-No (ix) Group-Yes vs. Individual-Yes, (x) Group-Yes vs. Individual-No (xi) Group-No vs. Individual-Yes, (xii) Group-No vs Individual-No. Each pair was presented 25 times, resulting in a total of 450 trials (150 forced = 25 * 6, and 300 free = 25 * 12). The task duration ranged from 10 to 20 min, depending on the reactivity of the participant.

As no questionnaires in the literature assessed the self-reported influence of conformity and obedience in a neutral context, we created a six-item questionnaire, with three items targeting conformity and three items targeting obedience. Participants had to rate on a scale from 0 (‘never’) to 5 (‘all the time’) how frequently they are influenced by these two forms of social influence. The questionnaires were presented in the native language of participants.

General data analysis and statistical approach

Transparency and openness

All data, analyses codes, Bayesian models, and research materials are available on Open Science Framework (https://osf.io/2xrfg/). Data were analysed using R and JASP.

EEG recordings

EEG recordings were conducted using Biosemi equipment (see http://www.biosemi.com for hardware details), with data acquired at a sampling rate of 2048 Hz from 32 channels placed according to the international 10-20 system. Additionally, four additional electrodes were used to capture horizontal eye movement and mastoid signals. The latter two were registered in case we would have too many bad channels due to the testing conditions in some countries, impeding the possibility of using average referencing. The data acquisition was performed using the Actiview software.

EEG processing

Data were processed using MNE-Python (Gramfort et al. 2013). We downsampled the data to 512 Hz using the default Fast Fourier Transform method of the resample () function in MNE-python. We then applied a bandpass filter between 1 and 30 Hz, with the Finite Impulse Response method, a zero-phase delay and the hamming window. We detected and interpolated bad channels automatically using the find_all_bads () function of the pyprep.NoisyChannels (mean = 1.92, SD = 1.55) (Bigdely-Shamlo et al. 2015). This function uses a combination of criteria: ‘extreme amplitudes (deviation criterion), lack of correlation with any other channel (correlation criterion), lack of predictability by other channels (predictability criterion), and unusual high frequency noise (noisiness criterion)’ in addition to the random sample consensus method (Fischler and Bolles 1987). After interpolating, a copy of the data was created in order to apply an automatic ICA, to detect eye movements, with a high-pass filter of 1 Hz, with a number of components calculated in order to represent 99.99% of the data. The high-pass filter of 1 Hz allows an improvement of the performance of the ICA (Winkler et al. 2015). To detect eye movements (i.e. blink and saccades) with the automatic ICA, we used the find_bad_eog () function in MNE-Python. This method calculates a correlation between the independent components and the electrodes that are labelled as EOG (i.e. electrooculography). We used as EOG the two external electrodes that recorded horizontal eye movement, as well as the Fp1 and Fp2 electrodes for the vertical eye movements as they are closest electrodes from the eyes. Independent components with a correlation higher than 0.5 were removed from the original data (mean = 2.12, s.d. = 0.32), and the copy of the data was not used thereafter. We visually checked the ICA components to ensure that they were correct, resulting in their reselection for 12/78 participants (images of the ICAs and selected components are available on OSF). We then re-referenced the channels using the reference-electrode standardization technique creating a point at infinity using a head model and the forward method (Yao 2001, Gramfort et al. 2013, Yao et al. 2019). The data were epoched on the electrodes Fz, Cz, FC1, and FC2 in a window from −2.5 to 2.5s around the keypress, which corresponds to the decision of the participants. These channels were selected, and averaged, as typically used to measure the FMθ (Cohen and Donner 2013, Kaiser and Schütz-Bosbach 2019, Messel et al. 2021, Levy et al. 2023) . Epochs containing artefacts were rejected based on the value of the mean, and the peak-to-peak magnitude, on a time window from −1.5 to 1.5, to focus more on the period of interest within each participant (see ‘Data removal & outliers’ detection’ section further).

Time-frequency representation (TFR) analysis

Time-frequency power was extracted for each trial using the tfr_morlet () function from MNE-Python. The parameters used were frequency range of 2–30 Hz with 80 logarithmically spaced bins, logarithmically spaced cycles from 4 to 14, and Fast Fourier Transform. As mentioned earlier, the epochs analysed were from −2.5 to 2.5 s around the keypress (response-locked). All power values in the Time-Frequency Representation (TFR) were normalized using the full-epochs length single trial correction [see more information on how below, and greater explanation in the paper of Grandchamp and Delorme (Grandchamp and Delorme 2011)]. We first performed a normalization on the full-epoch length within each trial and for each frequency. We considered the full-epoch length as being from −1.5 to 1.5 instead of the −2.5 to 2.5 window use previously to avoid edge artefacts (van Driel et al. 2012, Kaiser and Schütz-Bosbach 2021). The mean and s.d. of this period was computed on each trial. For each time-frequency point of each trial, we subtracted by the average and divided by the SD of the same trial. Finally, we took the average, and the SD of all trials within the baseline window period of 0.5–1.5s. Each trial was re-normalized using the averaged baseline and divided by the SD baseline. To resume, this method first normalizes using the full-length epochs values, then re-normalize using the average baseline across epochs. We cropped our epochs from −1.5 to 1.5s, then we averaged across all conditions and participant. Finally, we selected the value significantly different from the others within this time-frequency data. To find value significatively different we selected values above the mean + 1.96* standard deviation of all values. The formula provides a range of values within which we can reasonably expect the true population mean to fall with a certain level of confidence (i.e. 95% confidence). This value was used to create a circular mask for extracting FMθ power within the specific time and frequency windows (see Fig. 2 for visualization). Finally, for each trial, the mean value within this mask on the time/frequency window was extracted.

General statistical approach

Our main analysis method relied on Bayesian linear mixed models, using the ‘brms’ R packages (Bürkner 2017). For each analysis, we used four chains with 12 000 iterations including 2000 warm-up iterations. This allowed us to obtain 40 000 samples to precisely estimate the Bayes Factor (Makowski et al. 2019a). All models and

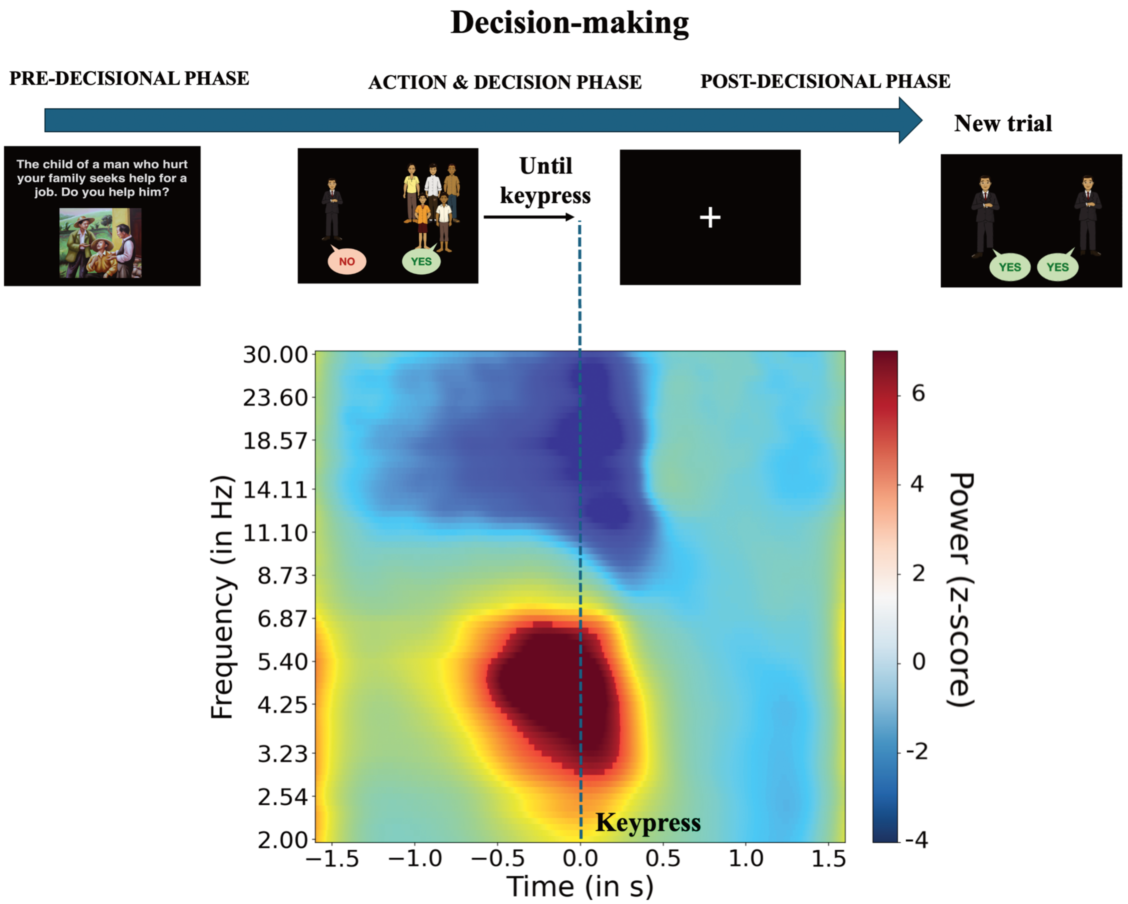

Figure 2. Response-locked time frequency power plots for the four electrodes (Fz, Cz, FC1, FC2). The representation is an average of each condition, and each participant together. The darker red delimitation is the zone with values significatively different using the mean + 1.96* standard deviation of all values. This delimitation was further used as a mask to extract FMθ within each trial.

their diagnostics are detailed in the Results section of the Supplementary Material, and the chains are available on OSF (https://osf.io/2xrfg/), as recommended by the guidelines of Kruschke (Kruschke 2021a). Based on the recommendation to examine posterior distributions, we reported the 89% high-density interval (HDI) and the probability direction (PD). The 89% HDI is an alternative to the classic 95% confidence interval, though is more computationally robust (Makowski et al. 2019a)—though it is of course no less arbitrary as a threshold values (McElreath 2016). The probability direction is the posterior proportion of a parameter having the same sign as the median (i.e. negative or positive and ranging from 50% to 100%). We interpret a PD higher than 95% (i.e. >95% chance that the parameter is positive or negative) with an HDI that does not overlap with 0 as evidence for a difference between conditions (Makowski et al. 2019, Kruschke 2021b). We also calculated the Bayes Factor (BF) as an indicator of how conclusive our results were. We calculated the BF using the probability of the prior being 0 (i.e. H0) divided by the probability of the posterior being 0 (i.e. H1), which is referred as to a BF_{10}. Values below (above) 1 indicate evidence in favour of H0 over H1 (H1 over H0). We took $BF_{10} < 1/3$ ($BF_{10} > 3$) as substantial evidence in favour of H0 (H1)—i.e. as substantial evidence that the two conditions are similar (different). Alternatively, $1/3 < BF_{10} < 3$ was taken as inconclusive evidence for either hypothesis (Dienes, 2019, 2014; Makowski et al., 2019b; Morey and Rouder, 2011; Schad et al., 2023; Wagenmakers et al., 2010). The BF is strongly dependent on the choice of the prior, so we also reported the robustness region (RR) of prior giving the same conclusion (as recommended in Dienes 2021; Kruschke, 2021a). This also provides additional information on which interpretation is the more likely for inconclusive evidence. The s.d. range of the prior that is more likely between H0 (i.e. $BF_{10} < 1/3$) and H1 (i.e. $BF_{10} > 3$) in case of inconclusive evidence will be favoured. For example, when there is inconclusive evidence but H1 is more likely given the SD range, we will interpret this as weak, inconclusive evidence in favour of H1.

For each parameter, we reported the estimated medians (Med), the 89% Highest Density Interval ($HDI_{89\%}$). Furthermore, for each comparison we reported the estimated medians difference (Med_{diff}), the 89% Highest Density Interval ($HDI_{89\%}$), the Probability Direction (PD), the Bayes Factor in favour of H_1 (BF_{10}), and the Robustness Range that lead to the same Bayes Factor conclusion (e.g. RR_{H0} if $BF_{10} < 1/3$ or RR_{IN} if $1/3 < BF_{10} < 3$).

Data removal and outliers' detection

For the RT, trials faster than 350 ms were removed as considered as too short for allowing an informed decision (Cohen and Donner 2013, Semmelmann and Weigelt 2017), resulting in 2.81% (s.d. = 6.06%) of rejected trials. We also removed trials that were outliers within each participant, due to behavioural or EEG data. We used the Inter-Quartile Range (IQR) with a threshold of 2 (therefore refer as 2IQR) to demarcate outliers (Jones 2019). For the FMθ, we used both the values of the mean and of the peak to peak to detect outliers with a time window of –1.5 to 1.5 s

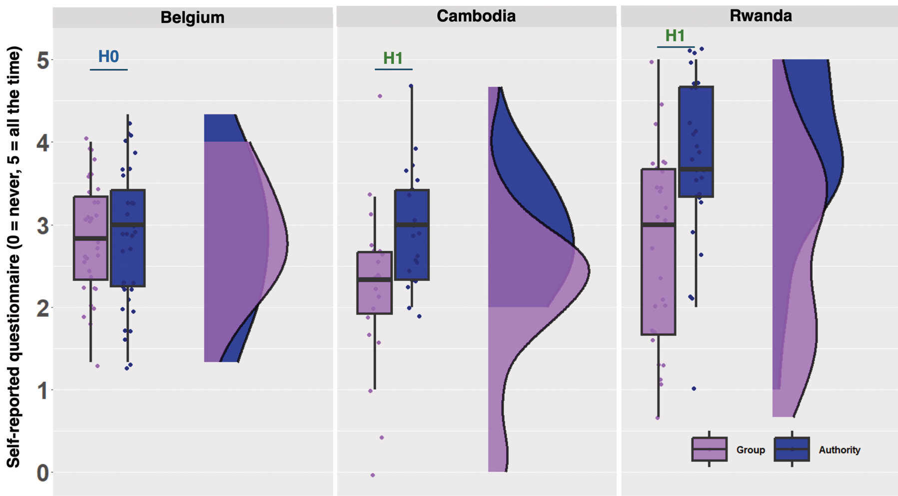

Figure 3. Graphical representation of the reported influence on a Likert scale ranging from “0” (not at all) to “5” (totally), respective the two main forms of social influence (i.e. Group in violet, and Authority in Blue) in each country. H0 represents evidence for similarity and H1 represents evidence for difference. Each dot represents a participant.

around the keypress. These method results in the rejection of 5.71% of trials (s.d. = 2.21%) for the DT, and 8.66% (s.d. = 8.04%) for the FMθ. At the end, the total rejection for DT is thus 8.34% (s.d. = 6.36%), which is the addition of fast trials rejection and the outliers detected with the 2IQR method.

Beyond removing outlier trials, we also removed outlier participants using the 2IQR method on each measurement. We calculated the outliers on the estimate slope of the model of the difference between the main conditions of interests (i.e. Individual vs. Authority; Individual vs. Group, Authority vs. Group; Helpful vs. Unhelpful intentions). Participants who were outliers in one of the four differences were removed from the analysis of this measure. For example, if a participant is detected as outlier in the estimated slope of the difference between Individual and Authority for the FMθ, this participant was not automatically be rejected for the DT. Based on this method, we removed 2/78 participants for the DT, 3/78 for the FMθ, and 6/78 for the behavioural selections.

Results

This section displays the results for the questionnaire, the percentage of behavioural selections, the DTs, and the mid-frontal theta. For each of these measurements, different models were computed, which are accessible in Supplementary Information S1, with Figure S1 for self-reports, Figure S2 for behavioural selection, Figure S3 for decision times and Figure S4 for mid-frontal theta activity.

Subjective questionnaire

We used a model with a cumulative family distribution, a probit link for mu, and an identity link for the disc (see Supplementary Information S1). This model was chosen due to the ordinal nature of Likert scale answers (Bürkner and Vuorre 2019). We included the interaction of Influence and Country, along with their main effects, as fixed effects. Items and participants were included as random intercepts. Additionally, Influence was included as a random slope per participant. The estimates are reported on the probit scale (standard normal z-scores).

When analysing all countries together, we observed evidence for a lower reported influence of the Group compared to the Authority ($\text{Med}_{\text{diff}} = -0.58$, $\text{HDI}_{89\%} = [-0.91\ \ -0.25]$, PD = 98.9%, $\text{BF}_{10} = 5.6$, $\text{RR}_{\text{H1}} = [1\ 2.0]$). When analysing countries separately (see Fig. 3), we observed evidence for similarity in Belgium between the Group and the Authority ($\text{Med}_{\text{diff}} = -0.03$, $\text{HDI}_{89\%} = [-0.40\ 0.45]$, PD = 54.3%, $\text{BF}_{10} = 0.25$, $\text{RR}_{\text{H1}} = [0.71\ 1]$). In Cambodia, we observed evidence for a lower reported influence of the Group compared to the Authority ($\text{Med}_{\text{diff}} = -0.66$, $\text{HDI}_{89\%} = [-1.16\ \ -0.18]$, PD = 98.1%, $\text{BF}_{10} = 3.04$, $\text{RR}_{\text{H1}} = [1\ 1.1]$). In Rwanda, we observed strong evidence for a lower reported influence of the Group compared to the Authority ($\text{Med}_{\text{diff}} = -1.10$, $\text{HDI}_{89\%} = [-1.57\ -0.64]$, PD = 99.9%, $\text{BF}_{10} = 44$, $\text{RR}_{\text{H1}} = [1\ 16]$). Comparisons between countries are available in Supplementary Information S2.

Percentage of selection

We used a model with a zero-inflated beta family distribution, a logit link for mu, and an identity link for both phi and zi (see Supplementary S1 for more information). This model was chosen due to the bounded nature of the percentage of selection (i.e. between 0% and 100%) and the possibility of having 0% selection for some stimuli (Tang et al. 2023). We included the interaction of Influence, Intention (i.e. Helpful and Unhelpful), and Country, along with their main effects, as fixed effects. Participants were not included as random intercepts because no variation in average selection was expected; only differences in the distribution of selection were anticipated. Finally, Influence and Intention were included as random slopes per participant. The estimates, originally in log-odds ratios, were transformed into odds ratios (OR) for ease of interpretation.

Social influence on the percentage of selection

When analysing all countries together, we observed strong evidence for a lower selection of the Individual compared to both the Group (OR = 0.65, $\text{HDI}_{89\%} = [0.58\ 0.73]$, PD = 100.0%, $\text{BF}_{10} = \text{Inf}$, $\text{RR}_{\text{H1}} = [0.5\ 17]$) and the Authority (OR = 0.69, $\text{HDI}_{89\%} = [0.60\ 0.79]$, PD = 100.0%, $\text{BF}_{10} = 2^{e3}$, $\text{RR}_{\text{H1}} = [0.5\ 10]$). We also observed weak

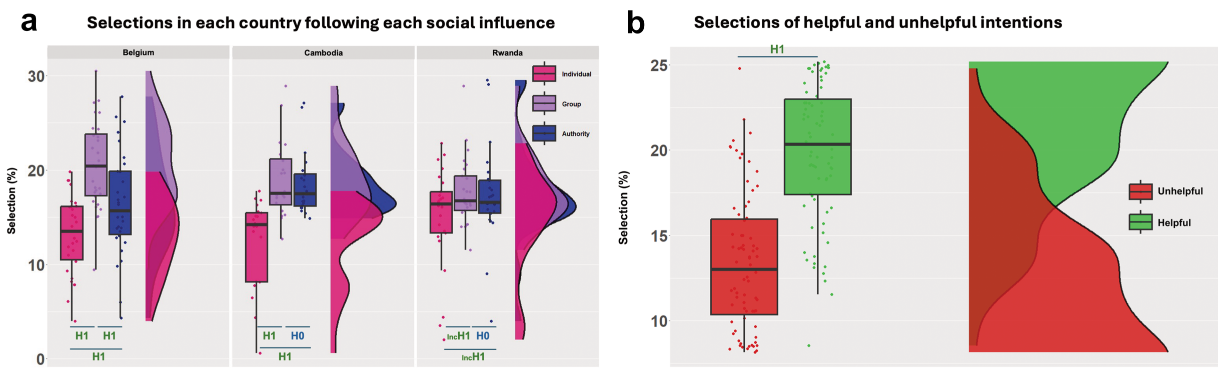

Figure 4. (a) Graphical representation of the selection, represented in %, respective of each form of social influence (i.e. Individual in pink - left box, Group in violet - central box, and Authority in blue - right box) in each country. (b) Graphical representation of helpful selections (in green-right box) and unhelpful selections (in red-left box) across countries. H_1 represents evidence for a difference. H_0 represents evidence for similarity, Inc H_1 represents inconclusive evidence for H_1 (i.e. PD above 95% and $HDI_{89\%}$ not overlapping 0, but BF_{10} inconclusive), Weak Inc H_1 represents weak inconclusive evidence for H_1 (i.e. PD below 95% and/or $HDI_{89\%}$ overlapping 0, BF_{10} inconclusive, but PD close to 95% with the RR_{in} indicating a prior change of conclusion being more likely for H_1 than H_0), and H_1 represents evidence for a difference. Each dot represents a participant.

inconclusive evidence for a higher selection of the Group compared to the Authority (OR = 1.10, $HDI_{89\%}$ = [0.98 1.22], PD = 91.7%, BF_{10} = 0.38, RR_{IN} = [0.06 0.57]).

When analysing countries separately (see Fig. 4a), we observed strong evidence in Belgium for a lower selection of the Individual compared to the Group (OR = 0.55, $HDI_{89\%}$ = [0.46 0.65], PD = 100.0%, BF_{10} = Inf, RR_{H1} = [0.5 23], and moderate evidence compared to the Authority (OR = 0.72, $HDI_{89\%}$ = [0.57 0.88], PD = 99.3%, BF_{10} = 5.2, RR_{H1} = [0.5 0.9]. We observed evidence for a higher selection of the Group than the Authority (OR = 1.29, $HDI_{89\%}$ = [1.08 1.51], PD = 99.2%, BF_{10} = 4.3, RR_{H1} = [0.5 0.8]). In Cambodia, we observed strong evidence for a lower selection of the Individual compared to the both the Group (OR = 0.62, $HDI_{89\%}$ = [0.50 0.75], PD = 100.0%, BF_{10} = 211, RR_{H1} = [0.5 10] and the Authority (OR = 0.65, $HDI_{89\%}$ = [0.48 0.81], PD = 99.6%, BF_{10} = 12, RR_{H1} = [0.5 1.9]. We observed evidence for similar selection comparing the Group and the Authority (OR = 1.05, $HDI_{89\%}$ = [0.85 1.25], PD = 64.2%, BF_{10} = 0.26, RR_{H0} = [0.4 0.5]). In Rwanda, we observed inconclusive evidence for a lower selection of the Individual compared to both the Group (OR = 0.79, $HDI_{89\%}$ = [0.65 0.94], PD = 98.0%, BF_{10} = 1.82, R_{IN} = [0.3 2.7], and the Authority (OR = 0.77, $HDI_{89\%}$ = [0.60 0.96], PD = 96.2%, BF_{10} = 1.33, RR_{IN} = [0.2 1.9]. We observed evidence for similar selection comparing the Group and the Authority (OR = 0.98, $HDI_{89\%}$ = [0.81 1.16], PD = 57.2%, BF_{10} = 0.22, RR_{H0} = [0.3 0.5]). Comparisons between countries are available in Supplementary Information S3.

Helpful and unhelpful selections

When analysing all countries together, we observed strong evidence for less selection of the unhelpful option compared to the helpful option (OR = 0.59, $HDI_{89\%}$ = [0.52 0.66], PD = 100.0%, BF_{10} = Inf, RR_{H1} = [0.5 23]), see Fig. 4b. Similarly, we observed strong evidence for less selection of the unhelpful option compared to the helpful option in Belgium (OR = 0.63, $HDI_{89\%}$ = [0.53 0.75], PD = 100.0%, BF_{10} = 772, RR_{H1} = [0.5 10]), in Cambodia (OR = 0.58, $HDI_{89\%}$ = [0.46 0.69], PD = 100.0%, BF_{10} = 981, RR_{H1} = [0.5 13]) and in Rwanda (OR = 0.56, $HDI_{89\%}$ = [0.45 0.66], PD = 100.0%, BF_{10} = Inf, RR_{H1} = [0.5 20]). Specific analyses on helpful and unhelpful selections in each country are available in Supplementary Information S4.

Decision times

We used a model with a shifted log-normal family distribution, an identity link for mu, and a log link for both sigma and non-decision time (see Supplementary S1 for more information). We chose this model as it is well-suited for fitting decision times and is easily interpretable (Rouder 2005, Lo and Andrews 2015, Anders et al. 2016). We included the interaction of Influence, Intention (i.e. Helpful and Unhelpful), Country, and Trial-Type (i.e. Forced choice and Free choice), along with their main effects, as fixed effects. Participants were included as random intercepts. Finally, Influence and Intention, as well as their interaction, were included as random slopes per participant.

Social influence on DTs

When analysing all countries together, we observed strong evidence for slower DTs for the Individual compared to both the Group (Med_{diff} = 82 ms, $HDI_{89\%}$ = [49 114], PD = 100.0%, BF_{10} = 228, RR_{H1} = [150 2^{e3}]) and the Authority (Med_{diff} = 183 ms, $HDI_{89\%}$ = [149 218], PD = 100.0%, BF_{10} = 2^{e8}, RR_{H1}= [150 1^{e4}]). We also observed strong evidence for slower DTs for the Group compared to the Authority (Med_{diff} = 101 ms, $HDI_{89\%}$ = [68 133], PD = 100.0%, BF_{10} = 1^{e7}, RR_{H1} = [150 5^{e3}]).

When analysing countries separately (see Fig. 5a), we observed strong evidence in Belgium for slower DTs for the Individual compared to both the Group (Med_{diff} = 117 ms, $HDI_{89\%}$ = [67 166], PD = 100.0%, BF_{10} = 249, RR_{H1} = [150 3^{e3}]) and the Authority (Med_{diff} = 196 ms, $HDI_{89\%}$ = [145 249], PD = 100.0%, BF_{10} = 3^{e11}, RR_{H1}= [150 1^{e4}]). We also observed evidence for slower DTs for the Group compared to the Authority (Med_{diff} = 79 ms, $HDI_{89\%}$ = [29 129], PD = 99.4%, BF_{10} = 5.0, RR_{H1} = [150 262]). In Cambodia, we observed strong evidence for faster selection of the Authority compared to the both the Individual (Med_{diff} = −145 ms, $HDI_{89\%}$ = [−209 −78], PD = 100.0%, BF_{10} = 81, RR_{H1} = [150 3^{e3}]) and the Group (Med_{diff} = -140 ms, $HDI_{89\%}$ = [−200 −78], PD = 100.0%, BF_{10} = 238, RR_{H1}= [150 3^{e3}]). We also observed evidence for similar DTs for the Individual and the Group (Med_{diff} = 5 ms, $HDI_{89\%}$ = [−54 66], PD = 56.1%, BF_{10} = 0.25, RR_{H0} = [122 150]). In Rwanda, we observed strong evidence for slower DTs for the Individual compared to both the Group (Med_{diff} = 122 ms, $HDI_{89\%}$ = [71 174], PD = 100.0%, BF_{10} = 349, RR_{H1} = [150 3^{e3}]) and the Authority (Med_{diff} = 207 ms, $HDI_{89\%}$ = [152 262], PD = 100.0%, BF_{10} = 4^{e10}, RR_{H1}= [150 1^{e4}]). We also observed strong evidence for slower

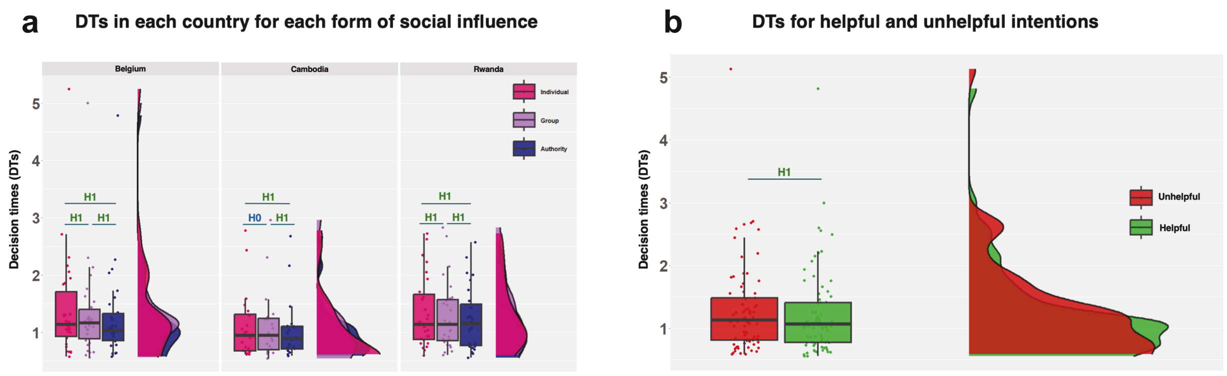

Figure 5. (a) Graphical representation of DTs (in sec) respective of each form of social influence (i.e. Individual in pink -left box, Group in violet -central box, and Authority in blue-right box) in each country. (b) Graphical representation of DTs for helpful selections (in green) and unhelpful selections (in red) across countries. H_0 represents evidence for similarity, and H_1 represents evidence for a difference. Each dot represents a participant.

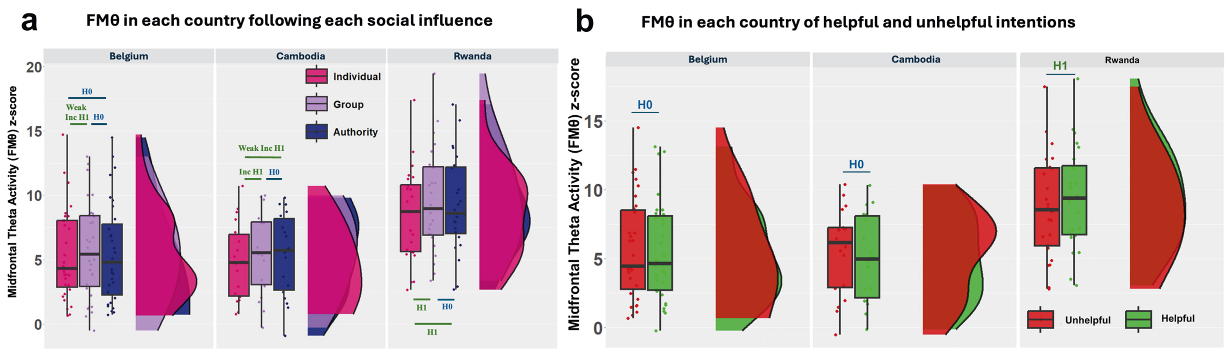

Figure 6. (a) Graphical representation of FMθ respective of each form of social influence (i.e. Individual in pink-left box, Group in violet-central box, and Authority in blue-right box) in each country. (b) Graphical representation of FMθ for helpful selections (in green) and unhelpful selections (in red) across countries. Inc H_1 represents inconclusive evidence for H_1 (i.e. PD above 95% and $HDI_{89\%}$ not overlapping 0, but BF_{10} inconclusive), H_0 represents evidence for a similarity, and H_1 represents evidence for a difference. Each dot represents a participant.

DTs for the Group compared to the Authority ($Med_{diff} = 85$ ms, $HDI_{89\%} = [33\ 136]$, PD = 99.6%, $BF_{10} = 7.2$, $RR_{H1} = [150\ 372]$). Comparisons between countries are available in Supplementary Information S5.

DTs for unhelpful and helpful selections

When analysing all countries together, we observed strong evidence for slower DTs of the unhelpful option compared to the helpful option ($Med_{diff} = 120$ ms, $HDI_{89\%} = [86\ 157]$, PD = 100.0%, $BF_{10} = 1^{e6}$, $RR_{H1} = [150\ {>}1^{e3}]$), see Fig. 5b. Similarly, we observed evidence for slower DTs of the unhelpful option compared to the helpful option in Belgium ($Med_{diff} = 143$ ms, $HDI_{89\%} = [87\ 196]$, PD = 100.0%, $BF_{10} = 1^{e3}$, $RR_{H1} = [150\ 5^{e3}]$),in Cambodia ($Med_{diff} = 95$ ms, $HDI_{89\%} = [29\ 159]$, PD = 99.0%, $BF_{10} = 4.06$, $RR_{H1} = [150\ 213]$), and in Rwanda ($Med_{diff} = 124$ ms, $HDI_{89\%} = [66\ 178]$, PD = 100.0%, $BF_{10} = 94$, $RR_{H1} = [150\ 3^{e3}]$) Specific analyses on helpful and unhelpful selections on DTs in each country are available in Supplementary Information S6.

Mid-frontal Theta (FMθ)

We used a model with a Gaussian family distribution, an identity link for both mu and sigma (see Supplementary Information S1 for more information). We included the interaction of Influence, Intention (i.e. Helpful and Unhelpful), Country, and Trial-Type (i.e. Forced choice and Free choice), along with their main effects, as fixed effects. Participants were included as random intercepts. Finally, Influence and Intention, as well as their interaction, were included as random slopes per participant.

Social influence on FMθ

When analysing all countries together (see Fig. 6a), we observed strong evidence for lower FMθ following the Individual compared to following the Group ($Med_{diff} = -0.78$, $HDI_{89\%} = [-1.07\ -0.47]$, PD = 100.0%, $BF_{10} = 129$, $RR_{H1} = [{<}2\ 28]$) and moderate evidence compared to following the Authority ($Med_{diff} = -0.54$, $HDI_{89\%} = [-0.86\ -0.21]$, PD = 99.7%, $BF_{10} = 3.91$, $RR_{H1} = [2\ 2.6]$). We also observed evidence for similar FMθ following the Group and following the Authority ($Med_{diff} = 0.23$ $HDI_{89\%} = [-0.07\ 0.54]$, PD = 88.9%, $BF_{10} = 0.20$, $RR_{H0} = [1.2\ 2]$).

When analysing countries separately, we observed weak inconclusive evidence in Belgium for lower FMθ comparing the Individual and the Group ($Med_{diff} = -0.44$, $HDI_{89\%} = [-0.87\ -0.00]$, PD = 94.7%, $BF_{10} = 0.51$, $RR_{IN} = [0.3\ 3.3]$). We observe evidence for similar FMθ comparing the Authority and both the Individual ($Med_{diff} = 0.13$, $HDI_{89\%} = [-0.34\ 0.60]$, PD = 67.5%, $BF_{10} = 0.16$, $RR_{H0} = [0.9\ 2]$) and the Group ($Med_{diff} = -0.32$, $HDI_{89\%} = [-0.75\ 0.14]$, PD = 87.3%, $BF_{10} = 0.26$, $RR_{H0} = [1.5\ 2]$). In Cambodia, we observed inconclusive evidence for lower FMθ comparing the Individual and the Group ($Med_{diff} = -0.73$, $HDI_{89\%} = [-1.32\ -0.12]$, PD = 97.3%, $BF_{10} = 1.17$, $RR_{IN} = [0.8\ {>}100]$ and weak inconclusive evidence for lower FMθ comparing the Individual to the Authority ($Med_{diff} = -0.52$, $HDI_{89\%} = [-1.16\ 0.11]$, PD = 90.5%, $BF_{10} = 0.46$, $RR_{IN} = [0.3\ 2.8]$. We observed evidence for similar FMθ comparing the Group and the Authority ($Med_{diff} = 0.20$, $HDI_{89\%} = [-0.39\ 0.79]$, PD = 70.6%, $BF_{10} = 0.21$, $RR_{H0} = [1.2\ 2]$). In Rwanda, we observed strong evidence for lower FMθ comparing the Individual and both the Group ($Med_{diff} = -1.16$, $HDI_{89\%} = [-1.63$

–0.66], PD = 100.0%, BF_{10} = 201, RR_{H1} = [2 35] and the Authority (Med_{diff} = –0.97, $HDI_{89\%}$ = [–1.51 –0.45], PD = 99.8%, BF_{10} = 12, RR_{H1} = [2 8.1]. We observed evidence for similar FMθ comparing the Group and the Authority (Med_{diff} = 0.19, $HDI_{89\%}$ = [–0.33 0.67], PD = 72.1%, BF_{10} = 0.19, RR_{H0} = [1.1 2]). Comparisons between countries are available in Supplementary Information S7.

FMθ for unhelpful and helpful selections

When analysing all countries together, we observed evidence for similar FMθ between unhelpful and helpful selections (Med_{diff} = -0.07, $HDI_{89\%}$ = [–0.32 0.19], PD = 65.9%, BF_{10} = 0.09, RR_{H0} = [0.5 2]). For each country separately (see Fig. 6b), we also observed similar FMθ between unhelpful and helpful selections in Belgium (Med_{diff} = 0.19, $HDI_{89\%}$ = [–0.17 0.57], PD = 80.3%, BF_{10} = 0.17, RR_{H0} = [0.9 2]) and Cambodia (Med_{diff} = 0.32, $HDI_{89\%}$ = [–0.18 0.82], PD = 84.8%, BF_{10} = 0.27, RR_{H0} = [1.5 2]). However, in Rwanda, we observed evidence for lower FMθ for unhelpful selections compared to helpful selections (Med_{diff} = -0.71, $HDI_{89\%}$ = [–1.15 –0.32], PD = 99.8%, BF_{10} = 5.99, RR_{H1} = [2 4.0]). Specific analyses on helpful and unhelpful selections on FMθ in each country are available in Supplementary Information S8.

Discussion

The present preregistered study aimed to compare the respective influences of conformity and obedience on prosocial intentions towards the child of a man who had hurt one's family in the past. We used a multimethod approach, relying on subjective self-reported questionnaires, behavioural observations (i.e. percentage of selections), implicit measurements (i.e. decision times, DTs), and EEG (i.e. mid-frontal theta activity, FMθ) to draw our conclusions. Additionally, the study aimed to be culturally sensitive to avoid making unreliable over-generalizations. Cross-cultural approaches indeed acknowledge the diversity of human experiences and the importance of considering cultural contexts before drawing conclusions, an aspect still largely overlooked by experimentalists (Arnett 2016, Caspar 2024a). Henrich and colleagues (Henrich et al. 2010) indeed revealed that WEIRD populations represent only 12% of the world population and are very peculiar at the psychological level, to such an extent that they could even be considered outliers. We therefore conducted the present study in three geographically distant countries, namely Belgium, Rwanda, and Cambodia, to account for potential cultural differences. Importantly, when we mention the names of the countries in the present study, the results should be interpreted through the lens of a cross-cultural approach rather than as a strict comparison between those countries, as similarities with neighbour countries cannot be excluded.

At the subjective level, we observed that participants overall reported being more influenced by an authority figure (i.e. obedience) than by a group (i.e. conformism). However, we also observed cross-cultural differences that temper this conclusion. While this was the case in Cambodia and Rwanda, we found that in Belgium, participants rated the influence of authority and conformity to the group similarly. Furthermore, Belgium rated higher conformity to a group than Cambodia, despite suggestions that collectivist cultures promote conformity (Triandis 2001, Oyserman et al. 2002). Previous research generally found that people from a Western European cultural heritage score higher on individualism and lower on collectivism than people of East Asian cultural heritage (Triandis 1990). However, the common views that separate countries based on their collectivism and individual has also been more recently challenged, notably as western countries have become increasingly multicultural compared to other countries and due to the rapid economic growth and progresses in several Asian nations (Oyserman et al. 2002, Parker et al. 2009, Takano and Osaka 2018). Also, we observed that in Rwanda participants reported a greater overall influence of authority than participants both in Cambodia and in Belgium. This result aligns with a previous study that found Rwandans living in Rwanda scored higher on a scale assessing the importance given to authority than Rwandans living in Belgium, thus accounting for the acculturation phenomenon (Caspar et al. 2022a). This result is supported by several studies showing that in Rwanda, there is a strong cultural relationship to authority (Prunier 1998, Paluck and Green 2009) (Lacey 2004). To the best of our knowledge, conformity and authority assessments have never been conducted in Cambodia or neighbour countries, thus limiting our inferences based on previous literature. A notable limitation is that this questionnaire was created for the present study. Additional work is necessary to reinforce the conclusions it draws.

A cross-cultural meta-analysis on conformity revealed that collectivist countries tended to show higher levels of conformity than individualist countries with an Asch-type line judgment task (Bond and Smith 1996). Following this study, we could have expected that in Belgium, a typical western country (i.e. more individualist), participants would have been less influenced by the group than participants in Rwanda or in Cambodia (Triandis 1990). Our results on the percentage of selection overall showed strong evidence that our participants were more influenced by both the authority figure and the group than by the individual presented alone, showing the influence of obedience and conformity. Interestingly, we observed that in Belgium participants were also more influenced by the group compared to the authority. In Rwanda and in Cambodia, participants were more influenced by both the group and the authority compared to the individual alone, although this effect was inconclusive in Rwanda. The fact that in Belgium selections were less influenced by the authority than by the group can be explained by a lower importance given to authority figures in Belgium compared to Rwanda, for instance (Caspar et al. 2022a), and a general greater habits and possibility of protesting against power (Meyer and Tarrow 1997, Casquete 2006, Vliegenthart et al. 2016). Additionally, studies have suggested that deference to authority may be more significant in collectivist cultures than in the West (Hamilton and Sanders 1995). However, in addition to the many studies that have now challenged the classic individualist/collectivist dichotomy mentioned above (Oyserman et al. 2002, Parker et al. 2009, Takano and Osaka 2018), the present task was also significantly different from Asch's line study on several aspects, notably, the prosociality associated with the selections and the addition of an obedience form of social influence.

We then analysed whether these results would be similar regardless of whether the selection was helpful or unhelpful. We observed strong evidence that our participants tended to choose helpful over unhelpful intentions in the three countries, suggesting a global preference for prosocial actions. Specifically, for both helpful and unhelpful intentions, we observed that the individual had less influence than both the group and the authority figure on participants' selections. This result emphasizes the power of conformity and obedience on social actions, compared to a simple peer individual. When analysing these results within each country, we observed that for both helpful and unhelpful intentions, participants in Belgium were more influenced by the group compared to the authority and the individual alone. In Cambodia and Rwanda, the group and the authority had a similar influence on unhelpful intentions compared to the individual alone. However, for helpful intentions, we observed a similar pattern in Cambodia but not in Rwanda, where we observed similar influence of the individual alone, the group and the authority. These results suggest that, in Rwanda, conformity and obedience did influence unhelpful intentions but not helpful ones. Taken together, such results showed that even if some common behavioural patterns can be observed, conformity and authority appear to have different influences on reconciliation intentions depending on the country. It would however have been relevant to evaluate the basic choice of our participants for helpful and unhelpful intentions, without any forms of social influence, in order to evaluate if even compliance to a peer can promote prosociality.

For DTs, we observed strong evidence across all countries that participants were faster for helpful intentions compared to unhelpful intentions. As shorter DTs in decision-making have been associated with easier decisions (Chen and Fischbacher 2020), our results indicate that, overall, it is easier for people to select helpful intentions than unhelpful intentions, suggesting again a tendency towards prosociality. We also observed strong evidence that participants were faster to follow the authority compared to following the group or an individual. This result was similar in Belgium and Rwanda, but slightly different in Cambodia, where we observed that authority led to faster DTs than the group and the individual, but the latter two did not differ. However, we also observed that DTs were generally faster in Cambodia. It may be the case that participants in Cambodia took less time to deliberate on their decisions, which may have reduced the differences. Interestingly, this result was similar for both helpful and unhelpful intentions in all countries. It thus appears that, at implicit levels, authority facilitates decision-making across different cultures, regardless of the prosociality or antisociality of the decision.

At the neural level, we observed lower FMθ following the individual compared to following the group or the authority, for which we have evidence of similarity. Initially, we hypothesized greater FMθ following the individual than the group or the authority, as the latter two involve lower cognitive conflict. However, our hypothesis was based on decision paradigms (e.g. go/no-go tasks, Stroop tasks) that did not involve choices to consider. In the literature, a higher FMθ has been interpreted as a marker of cognitive conflict (Cohen and Donner 2013, Lin et al. 2018, Lange et al. 2022, Levy et al. 2023) or more generally as cognitive control (Cavanagh and Frank 2014, Kaiser and Schütz-Bosbach 2019, Messel et al. 2021). According to this literature, our results could suggest that the greater influence of a group or an authority may be facilitated by the inhibition of alternatives (i.e. higher cognitive control)—in our case, the influence of an individual (Messel et al. 2021, Levy et al. 2023). A previous study showed a greater N2, as a sign of greater cognitive conflict, in authority-based decision compared to conformity-group decision (Xie et al. 2016). Together, it could suggest that obedience and conformity involve both more cognitive control and cognitive conflict. However, additional studies are necessary to confirm and investigate how obedience and conformity influence cognitive conflict and cognitive control.

Still at the neural level, we observed that helpful intentions led to similar FMθ as unhelpful intentions in Belgium and Cambodia, but not in Rwanda, where FMθ was higher for unhelpful intentions than for helpful intentions. Based on the above-mentioned literature, it may be suggested that in Rwanda, choosing the unhelpful intention facilitates the inhibition of the alternatives, and makes the decision being easier to take. This difference between Rwanda and the other two countries was not initially anticipated but can be explained by our specific task and the country's history. Our task indeed targeted helpful intentions towards the child of a man who hurt one's family in the past. Rwanda has experienced genocide more recently than Cambodia, with the Khmer Rouge regime (Kiernan 2008), and Belgium, which was rapidly invaded during World War II by the Nazis (Lagrou 1999). The participants we tested in Rwanda were from the first generation born after the genocide and are frequently confronted with the question of reconciliation (Hodgkin 2006). As the wound may be more vivid in Rwanda compared to the other countries, this may account for a greater facilitation to choose unhelpful intentions. Conducting a similar study in other countries or with different social intentions should help determine the respective influence of task parameters and a country's history on the results. Furthermore, the results obtained on FMθ do not imply that similar directional effects will be observed with other neurocognitive processes. In this study, focusing on FMθ, we addressed only the action and decision phase. Additional studies are required to assess whether obedience and authority have similar influences on other phases of decision-making.

Taken as a whole, we observed commonalities and dissociations between the results obtained from our different measurements. For instance, while participants subjectively reported that authority had a greater influence on their behaviours than a group, the selection results showed similar selections following a group or an authority, or even the opposite in Belgium with higher influence of the group than the authority. DTs indicated that it might be easier for participants to follow an authority figure, corroborating the questionnaire results. However, FMθ results showed greater activity for both the group and the authority compared to the individual, supporting the selection results. Interestingly, our results for DT and FMθ, taken together, suggest that a group or an authority involves both lower cognitive conflict (i.e. shorter DT) and greater inhibitory control (i.e. higher FMθ) than an individual. These findings overall highlight the importance of a multi-method approach encompassing different degrees of implicitness to draw comprehensive conclusions. A limitation, however, is that our questionnaire did not address the influence of a single individual and focused only on obedience and conformism. Therefore, the parallel between the questionnaire and the other measurements should be tempered in this regard, as including a source of social influence could have provided additional insights into the forms of social influence.

The literature on conformity has established a dual process, where individuals can be influenced at the informational level and at the normative level (Toelch and Dolan 2015). On the one hand, individuals use social cues to acquire information about behaviours that are considered accurate as shared by a larger group, a process known as 'informational influence'. On the other hand, individuals also conform because they want to adhere to established group norms to demonstrate belonging and avoid social exclusion or social tension. This process is known as 'normative influence'. In the present study, our group influence was informational because participants were given the opinion of the group and could decide whether to follow it or not. However, we did not account for normative influence, which remains an open question.

Another important element is that western countries have more cultural diversity than other nonwestern countries overall (Fasel et al. 2013). The testing in Belgium took place in Brussels, which is a highly culturally diverse city (Bousetta et al. 2018). It has been previously shown that in Belgium, both ethnic and cultural diversity is approximately 40% higher than in Rwanda and Cambodia (Fearon 2003). Furthermore, following the World Population Review, Brussels ranks within the top 15 most culturally diverse cities in the world. It is well-known that individuals living in foreign countries have an acculturation phenomenon, where they take part of the local culture (Berry 2005). However, this possible mixed on ethnicity and cultural differences in our sample in Belgium was not taken into account, and may have reduced some of the effects between Belgium and the other countries. Additionally, the paradigm we used was fictional, as we asked participants to imagine themselves in the situation. Since this study was the first ever conducted in Cambodia using EEG, we decided to use a relatively simple and straightforward paradigm that had been used before in other countries, such as Rwanda (Pech et al. 2023). As the task was well-received and understood, more complex and ecological paradigms could be implemented in future studies.

Conformity and obedience are not just theoretical concepts; they have real-world implications, affecting everything from organizational behaviour to political dynamics. For instance, employees might adopt corporate culture or practices without question, or authority figures might lead to the unchallenged acceptance of policies and regimes, sometimes resulting in oppressive governance or the perpetuation of social injustices. This study shows that both conformity and obedience influence helpful and unhelpful intentions towards the child of someone who hurt one's family in the past, highlighting their importance in a reconciliation process. However, our cross-cultural approach suggests that their respective influences may differ depending on the country. In addition to complementing the literature on obedience and conformity, this study also serves as a proof-of-concept that, thanks to the increased portability of materials, cross-cultural approaches are becoming more feasible in neuroscience, leading to greater generalizability of the results in the field.

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Author contributions

E.A.C. and G.P.P. developed the study concept. E.A.C. and G.P.P. created the method and scripted the task. E.A.C. and G.P.P. travelled and completed data collection. G.P.P. analysed the data. G.P.P. wrote the first draft of the manuscript and E.A.C. provided comments. All authors agree with the final version.

Supplementary data

Supplementary data is available at SCAN online.

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