Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

How Does Empathy Modulate Susceptibility to False Memory?

Shih-Yu Lo (shihyulo@nctu.edu.tw)
National Yang Ming Chiao Tung University

Research Article

Keywords: empathy, misinformation paradigm, false memory, self

Posted Date: May 28th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-542411/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Abstract

Based on the view that the function of empathy is to integrate one's concepts of the self and others, we hypothesised that empathy facilitates memory by relating external events to self-related information. However, whether empathy's facilitative effect on memory applied to misleading information was unknown. To test this, we used a misinformation paradigm on a sample of 51 participants aged 20–42. Participants were fed misleading information after watching videos that evoked different degrees of empathy. The results showed that the participants' susceptibility to misleading information was lower for videos that provoked a high degree of empathy compared to videos that provoked a low degree of empathy. Based on our data, we conclude that empathy can prevent people from being misled by false information.

Introduction

Empathy

In the English language, the term 'empathy' was first coined by Edward Titchener (1867–1927) in 1909 as a way to describe people's ability to feel or understand what other people are experiencing. *Dispositional empathy* is defined as a personality trait that varies between individuals [1], while *situational empathy* is triggered by external events [2]. In the study of Klimecki, et al. [3] study, for example, situational empathy could be evoked in the participants by presenting short videos to them. Then, they engaged in a dictator game in which they had absolute power to distribute money to whomever they want. The results showed that people tended to distribute money to strangers after watching films that induced a higher degree of empathy.

Empathy and self

In psychology, the self is a very important topic. From an evolutionary perspective, people have to understand the self and learn how to protect themselves in order to survive. One effect of empathy is to blur the boundaries between one's concepts of the self and others, so people are willing to extend their protection to other individuals. Empirical evidence for this view was provided by Batson, et al. [4] by use of the Inclusion of Other in the Self (IOS) scale [5,6]. Participants were presented with two circles with varying degrees of overlap. One of the two circles represented themselves, and the other represented others. Batson, et al. [4] found that, compared to the neutral group, participants in whom empathy was induced tended to choose circles with more overlap.

The representation of the self can modulate processes at multiple levels of the cognitive system. In the perceptual domain, people are more sensitive to their own faces than the faces of others [7–9]. In the attention domain, self-related information captures attention even when it is irrelevant [10,11]. The aforementioned self-superiority effect can even be evident with abstract symbols. In the study of Sui, et al. [12], participants were instructed to associate themselves, a friend or a stranger with three geometric pattern (a circle, triangle or square), and their perceptual judgments of the pattern representing themselves was better than those of the patterns representing others. Thus, it can be hypothesised that if the function of empathy is to blur the boundary between one's concepts of the self and others, people with a higher degree of empathy should demonstrate the least degree of sensitivity to self-related stimuli compared to others. To test this hypothesis, one aim of this study is to examine the correlation between dispositional empathy and differences in perceptual judgements between self-related and other-related symbols.

The function of empathy: facilitating memory

Another aim of this study is to examine the effect of empathy on memory. Research in the 1970s showed that memory performance could be improved if one relates a memory with themselves [13]. Additionally, brain imaging evidence has shown that self-related memories are associated with a more extensive network of brain areas than self-unrelated memories [14]. If the representation of the self can facilitate the formation of memory, a reasonable conjecture is that empathy should facilitate remembrance of external events by associating the memories with the self. In the study of Pohl, et al. [15], empathy was indeed shown to positively predict memory.

That empathy facilitates memory can be a double-edged sword because memories are not necessarily accurate. Memory researchers have postulated that memory operates according to dual-process models. In such models, memory performance is determined by the participants' *recollection* of or *familiarity* with a past event [16–18]. If someone successfully recalls or recognises an event, it could be because they have clear recollections for this event, or simply because they have a high degree of familiarity with this event.

Such a recollection/familiarity distinction is in line with the fuzzy trace theory of memory [19–21], where stimuli are encoded in two independent traces: the verbatim traces and the gist traces. The former represent the perceptual details of an event, while the later represent the meaning, or the gist of an event. If a gist trace is sufficiently strong, participants might confuse the strength of a gist trace with subjective feelings of recollecting, producing a phenomenon known as phantom recollection [22], leading to the formation of false memories.

A conflation between familiarity and recollection can also be predicted by the activation-monitoring theory [23]. According to this theory, exposure to a certain stimulus activates the semantic representation of this stimulus. When one is presented with false information after experiencing the original event, both the representations for the original event and the post-event misleading information are activated; as a result, false memories emerge because people misattribute the activations for the representations of the misleading information to the original event.

Given that the function of empathy is to facilitate memory, we propose two hypotheses regarding how empathy exerts influence on false memory. According to the *disambiguated recollection* hypothesis, empathy facilitates memory encoding in the first place, preventing memories from being overwritten by post-event misinformation. According to the *misattributed familiarity* hypothesis, empathy increases one's familiarity with the original information as well as post-event misinformation, prompting people to mistakenly report the misinformation.

The way in which people are affected by misinformation has been intensively examined by the misinformation paradigm [24,25]. This paradigm comprises three stages. In stage 1, the participant witnesses an event. In stage 2, some participants were fed misinformation. In stage 3, participants were instructed to recall or recognise the event in stage 1. Evidence has shown that people tend to recall the misinformation in stage 2 as true events occurring in stage 1 [26–31]. Van Damme and Smets [32] found that negative emotion facilitates the encoding of real as well as false memories. In the present study, we used the same paradigm but manipulated the degree of empathy instead of emotion in order to test the role of empathy in one's belief in misleading information.

Research design

We modified the experimental paradigm used by Van Damme and Smets [32], presenting the participants with short videos that provoked different degrees of empathy and then feeding half of them misleading information. The influence of misleading information on memories could be inferred by comparing the memory performance of the participants who were fed misinformation and the participants who were not.

Previous research on emotion has shown that emotion enhances memory for central information, while it did not affect, or even suppressed memory for peripheral details [33,34]. In the present study, we defined the central information as noticeable information in the videos, and peripheral information as unnoticeable details. We thus designed a set of questions for each video, and collected the participants' response accuracy to these questions in a pre-test. Central information was defined as the information in questions where participants could answer with a high accuracy, and peripheral information was defined by the information in questions where participants answered with a low accuracy.

A three-factor mixed-designed experiment was conducted. The between-subject factor was Group, where half of the participants were fed misleading information and the other half was not. One within-subject factor was Empathy, for which each participant viewed a set of videos that provoked high degree of empathy and another set of videos that provoked low degree of empathy. The other within-subject factor was Difficulty, for which the participants had to answer one question regarding the central information (easy question) and one question regarding the peripheral information (hard question) for each video. For both of the two questions, participants in the misleading group were fed misleading information, and therefore the participant's responses in these two questions was the index of false memories. In addition to two critical questions that were used to probe the formation of false memories, participants also had to answer four true-memory questions regarding true information in the video, with a correct answer of yes for two of them and a correct answer of no for the other two.

In addition to the memory task, we also incorporated another aim into the experiment: to test the extent to which dispositional empathy caused one to associate a geometrical pattern with themselves.

Participants were tasked with associating themselves, friends, and strangers with different geometrical patterns. As previous research has demonstrated that people had higher sensitivity to patterns associated with themselves, we tested whether this self-superiority effect varied with participants' degree of empathy.

Results

Manipulation check

In the main experiment, we used six high empathy-inducing videos and six low empathy-inducing videos, based on a pre-test that measured the perceived empathy. To ensure that the two sets of videos differed only on the dimension of empathy, we deliberately chose the two sets that did not significantly differ on any dimension of emotion[35] including positive valence, negative valence, or arousal. Positive valence represents a high degree of pleasure, whereas negative valence represents the opposite; the degree of arousal refers to the level of physical activation evoked by the emotional event.

However, the data in the main experiment still showed that the degree of negative valence ($F[1, 50] = 14.79$, $p < .001$, $\eta^2_{partial} = .23$) as well as arousal ($F[1, 50] = 26.31$, $p < .001$, $\eta^2_{partial} = .34$) was significantly higher for the high empathy-inducing videos than for low empathy-inducing videos. To fix this, we removed the most arousing video in the high-empathy group and the least arousing video in the low-empathy group. For the remaining 10 videos with 5 videos in each group, the ratings of perceived empathy were still significantly higher for the high empathy-inducing videos than for low empathy-inducing videos ($F[1, 50] = 42.67$, $p < .001$, $\eta^2_{partial} = .46$), but the ratings for positive valence ($F[1, 50] = 2.55$, $p = .12$, $\eta^2_{partial} = .05$) and negative valence ($F[1, 50] = 2.69$, $p = .11$, $\eta^2_{partial} = .05$) were not significantly different between the two sets of videos. Nevertheless, the effect on arousal still reached statistical significance ($F[1, 50] = 6.42$, $p = .01$, $\eta^2_{partial} = .11$), despite the much lower effect size ($\eta^2_{partial} = .11$) compared to perceived empathy ($\eta^2_{partial} = .46$). All the reported data below are based on the 10 remaining videos, and the possible confounding effect of arousal will be discussed.

For the remaining 10 videos, The difficulty indices (based on a pre-test) for the critical easy questions did not significantly differ between the high empathy-inducing and low empathy-inducing videos ($t[40] = 0.04$, $p = .97$). The same was true for the critical hard questions ($t[40] = 0.38$, $p = .70$). Therefore, if there was any effect of empathy on memory, the effect was not confounded with difficulty, as the questions we used to test the memory performance had equal levels of difficulty between the high empathy-inducing videos and low empathy-inducing videos.

Memory performance

The misinformation effect could be indexed by the difference between the accuracy of the critical questions in the misleading group and that in the control group. The critical questions were two-alternative choice questions; one option was the correct answer, and the other was wrong information only provided in the misleading group. Any accuracy reduction in the misleading group compared to the control group should be due to the misinformation that was provided only to the misleading group.

We used a mixed-design analysis of variance (ANOVA) with the factors of Group (between-subject: misleading vs. control), Empathy (within-subject: high empathy vs. low empathy) and Difficulty (within-subject: easy vs. hard) on the accuracy of critical questions. There was a three-way interaction among the three factors ($F[1, 49] = 4.36$ $p = .04$, $\eta^2_{partial} = .08$), and thus we separated the critical easy questions (central information) and critical hard questions (peripheral information) into two different ANOVAs.

For the critical easy question (Fig. 1a), Group had a significant effect ($F[1, 49] = 16.48$, $p < .001$, $\eta^2_{partial} = .25$); the accuracy of the misleading group ($M = 0.77$) was lower than that of the control group ($M = 0.91$). Therefore, our manipulation on the misinformation was successful. However, empathy had no significant effect ($F[1, 49] = 1.28$, $p = .26$, $\eta^2_{partial} = .03$), and there was no interaction between the two factors ($F[1, 49] = 0.32$, $p = .58$, $\eta^2_{partial} = .006$).

For the critical hard questions (Fig. 1b), there was a significant interaction between Group and Empathy ($F[1, 49] = 4.06$, $p = .049$, $\eta^2_{partial} = .08$). This interaction could be understood as follows. For the low empathy-inducing videos, there was decrease of 0.31 in accuracy when comparing the misleading group with the control group. The corresponding accuracy decrease was significantly smaller for the high empathy-inducing videos, reaching only 0.14. In other words, a high degree of empathy prevented participants from being misled. It should be noted that the difficulty indices for the critical questions did not differ between the high empathy-inducing and low empathy-inducing videos based on a pre-test. Therefore, the questions for the high empathy-inducing videos were not particularly easier, and a reasonable way to explain the lower susceptibility to misinformation for the high empathy-inducing videos is provoked empathy.

For the true-memory questions (Fig. 1c), we combined the two ‘yes’ questions and two ‘no’ questions to determine the overall accuracy for the veridical information in the videos. There was a significant effect for empathy ($F[1, 49] = 57.78$, $p < .001$, $\eta^2_{partial} = .54$), with participants answering the questions for the high empathy-inducing videos ($M = 0.80$) more accurately than for the low empathy-inducing videos ($M = 0.71$). There was no significant effect of Group ($F[1, 49] = 2.16$, $p = .15$, $\eta^2_{partial} = .04$) or interaction ($F[1, 49] < 0.01$, $p = .99$, $\eta^2_{partial} < .001$). This echoes Pohl et al.’s (2005) finding that empathy could positively predict memory. However, it was difficult to determine whether the better performance for true events in the high empathy-inducing videos was caused by empathy or whether the questions were easier, as we did not include the true-memory questions in the pre-test. Therefore, in the following discussions, we focus on the effect of empathy on false memories.

Role–shape matching performance

Participants also performed a role-shape matching task, where they had to associate themselves, a friend, and a stranger with different geometrical patterns. An instruction was given to, for example, associate themselves with a disc, a friend with a square, and a stranger with a triangle. Then they were presented with a text – 'you', 'friend', or 'stranger', together with a shape–a disc, a triangle or a square, and they had to decide whether the text and the shape matched or not, according to the instruction.

We first computed the *d'* value, which was an index of participants' capacity to discriminate a matched role–shape pair from a non-matched one. There was a significant effect of Role (me/friend/stranger) on *d'* ($F[2, 100] = 8.88$, $p < .001$, $\eta^2_{partial} = .15$). Post hoc analyses showed that significantly higher *d'* values were associated with the target pattern that represented 'you' compared to 'friend' ($t[50] = 3.51$, $p = .001$, Cohen's $d = 0.49$) and 'stranger' ($t[50] = 3.57$, $p = .001$, Cohen's $d = 0.50$). There was no significant difference between 'friend' and 'stranger' ($t[50] = 0.44$, $p = .66$, Cohen's $d = 0.06$).

We also analysed reaction time using the factors of Role (you, friend, stranger) and Matching (correct role–shape matching vs. incorrect role–shape matching). There was an interaction between the two factors ($F[2, 100] = 78.61$, $p < .001$, $\eta^2_{partial} = .61$). We then separated the match and mismatch conditions and found that Role had a significant effect in the match condition ($F[2, 100] = 102.9$, $p < .001$, $\eta^2_{partial} = .67$), but not the mismatch condition ($F[2, 100] = 3.01$, $p = .054$, $\eta^2_{partial} = .06$). In the match condition, post hoc analyses showed that there was a significant difference between the reaction time for the target pattern that represented 'you' versus 'friend' ($t[50] = 11.97$, $p < .001$, Cohen's $d = 1.68$) and 'you' versus 'stranger' ($t[50] = 11.97$, $p < .001$, Cohen's $d = 1.68$). However, there was no significant difference between 'friend' and 'stranger' ($t[50] = 1.30$, $p = .2$, Cohen's $d = 0.18$). The results for both *d'* and reaction time were consistent with the study of Sui, et al. [12], in which participants were required to imagine one of their best friends for the target role of 'friend'. We skipped this step in our procedure and obtained consistent results. Therefore, we believe that this step was not crucial.

To test the relationship between dispositional empathy and performance on their role–shape matching task, we first computed the selfness index by computing the difference in *d'* value and reaction time between the trials with the target shape representing 'you' and the trials with the target shape representing 'friend' and 'stranger'. Note that the index based on reaction time was computed from only the matching trials. We then computed the correlation between the selfness indices and the rating results in IRI, which is a measure of dispositional empathy. Pearson's r was − 0.12 between the IRI and selfness based on reaction time ($t[49] = 0.86$, $p = .39$), and was − 0.05 based on *d'* ($t[49] = 0.34$, $p = .73$). Neither value reached statistical significance.

Discussion

The results of the study show that empathy reduced participants' susceptibility to misinformation, but only for critical hard questions, not critical easy questions. Critical easy questions concerned noticeable details in the videos, and these details were probably already firmly consolidated before the participants were fed misleading information, regardless of how much empathy the videos provoked. For critical hard questions, on the other hand, more effort was required to complete the consolidation process and it was still incomplete when the participants were fed misinformation. This enabled empathy to exert a facilitative effect.

Empathy, memory and self

The results of the present study supported the *disambiguated recollection* hypothesis: empathy facilitated the memory consolidation process for the original events, so the participants had more unambiguous recollections of the events in the high empathy-inducing videos than those in the low empathy-inducing videos. Possibly, when people had greater empathy for the people depicted in the videos, they remembered the information from a first-person perspective, so the memory was more reliable. From the perspective of the fuzzy trace theory [19–21,36], a reasonable explanation is that empathy strengthens the verbatim trace for the original event; from the perspective of the activation-monitoring theory [23], a reasonable explanation is that empathy increases the activation level of the representation for the original event.

Empathy and memory might share a common mechanism, as indicated by the neuropsychological study of Beadle, et al. [37]. In that study, participants with hippocampal damage showed impairment in memory performance, and they reported lower cognitive and emotional traits of empathy. Additionally, Wagner, et al. [38] found that both cognitive and affective empathy were associated with memory formation for healthy adults. The data of the present work further support the existence of an association between memory and empathy.

If empathy is highly related to the concept of the self, the effect of the self should be related to empathy. This is why we tested how the trait of empathy correlated with performance in the role–shape matching task. In our study, we found a significant improvement in perceptual judgment for shapes that were associated with the self, replicating the results of Sui, et al. [12]. However, the degree of improvement in performance correlated very little with participants' empathy. One possibility is that the self–other merging effect applied only to situational empathy and not to dispositional empathy. In the study of Batson, et al. [4] who demonstrated the self–other merging effect, participants were presented with an emotional story. Half were instructed to imagine themselves as the people in the story, while the other half was instructed to stay objective. As a result, the different degrees of self–other merging between the groups could be attributed to situational empathy.

Empathy and emotion

To tease apart the effects of empathy and emotion, we deliberately chose two sets of videos that were supposed to provoke different degrees of empathy but equivalent degrees of valence and arousal based on the data collected in a pre-test. In the main test, both the degrees of positive valence and negative valence were fairly constant between the high empathy-inducing videos and low ones, while the degree of arousal was nevertheless significantly higher for the former type of videos. From a methodological perspective, we could not fully rule out the possible confounding role of arousal on the effect of empathy. From an ecological perspective, empathy and arousal might be two inseparable psychological phenomena that always occur together.

Empathic arousal is an element of empathy that appeared early during human development [39]. For example, the fact that children cry when they hear other people do so [40] is considered to be one of the earliest forms of empathy [40]. Similar phenomena can be observed in many non-human animal species [41]. According to the model proposed by Decety and colleagues[42–46], affective arousal is an important element that contributes to the experience of empathy, mediated by amygdala, hypothalamus and orbitofrontal cortex. Consistent with such a view, some researchers even used the degree of arousal as an implicit index of empathy[47]. Therefore, it is inevitable that the emergence of empathy would elicit a heightened degree of arousal.

While empathy and emotional arousal are highly associated, our data suggest that empathy and emotional valence can be dissociated. Like empathy, emotional information can be remembered better and more vividly than neutral information [48–50]. This is particularly true for negatively charged information [51]. However, negative valence of emotion and empathy play different roles in memories of post-event misinformation. We used the same experimental procedure to elicit false memories, as in the study of Van Damme and Smets [32], where the participants showed higher susceptibility to false information when shown videos that provoke negative emotions than neutral ones, and that was opposite of the effect of empathy. This discrepancy can be explained in terms of the recollection/familiarity dichotomy of memory performance. Stimuli that provoke a negative valence of emotion increase participants’ overall familiarity with whatever information is presented to them, making them more vulnerable to misleading information. On the contrary, stimuli that provoke a higher degree of empathy enable participants to be more likely to experience information from a first-person perspective, preventing their original memories from being overwritten by subsequent events.

Conclusion

Investigations into false memory have been pioneered by Loftus for over 30 years [52]. This topic has become even more important in recent years due to the rapid development of social media, as information—including misinformation—can spread across borders within seconds. The impact of misinformation can be quite damaging, particularly during global crises. At the time when this manuscript was being prepared, global society was suffering from the COVID-19 pandemic, and a recent study shows that belief in ungrounded conspiracy theories negatively predicted people’s intentions to take disease-preventing measures [53]. Empathy may be one of the psychosocial factors that can help alleviate the severity of the pandemic. Not only does empathy promote pro-social behaviour [54] but also empathetic commutation can prevent people from being misled by false information, as suggested by the data of the present study.

Method

Participants

The experimental protocol in this study was approved by the Research Ethics Committee for Human Subject Protection of National Chiao Tung University (Case number: NCTU-REC-108-001E), and all methods were performed in accordance with the relevant guidelines and regulations laid down by the ethics committee. Informed consent was obtained from all participants. According to Van Damme and Smets [32], the effect size (η^2) for how misleading information affected memory performance was 0.11 for peripheral details. We assumed an equivalent effect size should be observed in our study. G*Power 3 [55] was used to compute the required sample size. We set the test family as 'F test', the statistical test as 'ANOVA: Repeated measures, between factors', the number of groups as 2 and the number of measurements as 2. To achieve a power of 0.8, the sample size was estimated to be at least 50. We then recruited 51 participants (21 males) aged 20–42 (M = 22, SD = 2.03) based on convenience sampling. All the participants had normal or correct-to-normal vision, and reported no psychopathological or neurological disorders.

Procedure

We conducted two pre-tests prior to the main test. Pre-test 1 served to find usable videos to trigger different degrees of empathy, and pre-test 2 served to find questions that were suitable for eliciting false memories. It should be noted that the participants in pre-test 1, pre-test 2, and the main test were different. The participant characteristics mentioned in the Participant section applied only to the main test, because our conclusions were based only on the main test; pre-tests 1 and 2 were only used to find out appropriate materials for the main test.

Pre-test 1. To collect experimental materials, we followed a procedure similar to that of the Socio-affective Video Task (SoVT) (Klimecki, et al. [56]. We first collected short videos from documentaries, movie trailers, or TV shows. We assumed that, in most cases, videos that can provoke a higher degree of empathy are most likely to be those with a negative valence and high levels of arousal. We thus collected 110 videos that possessed these characteristics. In addition, we collected 10 videos that possessed a positive valence and high levels of arousal, 10 videos that possessed a positive valence and low levels of arousal, and 10 videos that possessed a negative valence and low levels of arousal. The duration of each video was approximately 20 seconds.

The valence and level of arousal were based on our own initial subjective evaluations, and then we embedded these videos in an online questionnaire on the Qualtrics platform. This questionnaire served as pre-test 1. We asked a group of 731 participants the following questions, and asked them to rate on a 11-point Likert scale (0 to 10): *(1) How much positive emotion did you feel in regard to this video? (2) How much negative emotion did you feel in regard to this video? (3) How aroused did you feel in regard to this video? (4) How much did you empathise with the people in the video?* Each participant had to fill out the ratings for 40 videos that were randomly selected from our set of 140. In accordance with the participant's ratings, we selected six videos that could provoke high degrees of empathy, and another six videos that could only provoke a low degree of empathy, while the two sets of videos induced the same degrees of positive emotion, negative emotion, and arousal. The difference in empathy ratings between these two sets of videos reached statistical significance ($t[10] = 10.96$, $p < .001$). In terms of positive emotion ($t[10] = 0.26$, $p = .80$), negative emotion ($t[10] = 1.36$, $p = .20$), and degree of arousal ($t[10] = 0.22$, $p = .83$), the two sets of videos did not differ significantly.

Pre-test 2. For each of the 12 selected videos, we designed four misleading questions. For example, one video was the movie trailer of "Wonder", depicting a boy who suffered from a medical facial deformity. The boy mentioned that he was ten years old. We then designed a question, *'how old was the boy in the video?'* and provided the options of 'ten' and 'eight'. This served as pre-test 2. We used Qualtrics to collect data from a group of 41 people. The error rate for each misleading question was used as an index of *difficulty* of this question. The error rate for the question presented above was 0.39, indicating that the likelihood for the participants to mistakenly answer 'eight' was 0.39.

Of the four misleading questions developed for each video, we chose one with high level of difficulty and labelled it as a hard question and then chose one with low level of difficulty and labelled it as an easy question. The difficulty level for the easy questions did not significantly differ between the high empathy-inducing and low empathy-inducing videos ($t[40] = 0.03$, $p = .97$). The same was true for the hard questions ($t[40] = 0.35$, $p = .73$).

Main test. After signing the consent form, the participants filled out the questionnaire of the Interpersonal Reactivity Index (IRI) [57], which measured their dispositional empathy. Then, they were guided to a computer to complete an online questionnaire on Qualtrics.

For a visualisation of the procedure, please refer to Fig. 2. Participants were randomly assigned into the *misleading* ($n_m = 27$) or *control* ($n_c = 24$) group. Both groups first viewed a short video. In order to ensure that they had paid attention, they were asked to orally summarise its content. Then, they had to rate four questions in the emotion-rating stage, on a 11-point Likert scale (0 to 10): *(1) How much positive emotion did you feel in regard to this video? (2) How much negative emotion did you feel in regard to this video? (3) How aroused did you feel in regard to this video? (4) How much did you empathise with the people in the video?*

After the emotion rating stage came the misinformation feeding stage, in which participants had to answer two questions that fed them misleading information. The two questions were modified from those used in pre-test 2. For example, the original misleading question in pre-test 2, *'how old was the boy in the video? (10/8)'*, was modified to *'do you remember how many surgeries the 8-year old boy had? (yes/no)'.* The two-alternative forced choice form in pre-test 2 was modified into a yes/no form to insinuate participants with misinformation. For the control group, the misleading information was removed from the questions; for example, they were asked, '*do you remember how many surgeries the boy had? (yes/no)'.* Four misleading questions were associated with each video in pre-test 2, but only two were chosen for each video in the main test: one with a high level of difficulty and one with a low level of difficulty.

The stages of video watching and summarisation, emotion rating and misinformation feeding were repeated three times for three different videos. Then, the participants were directed to another computer to complete the role–shape matching task, which served two purposes. Firstly, it served as a filler task to separate the video watching stage (memory acquisition) and the questions stage (memory testing), so the difficulty level of the memory task could be optimal; secondly, based on the previous study that showed a better identification performance for self-related shapes than other-related shapes [12], we could examine the relationship between empathy and the self by measuring how this self-superiority effect co-varied with the dispositional empathy.

The role–shape matching task was programmed in MATLAB r2014b with Psychtoolbox-3 extensions [58,59]. Visual stimuli were displayed on a 17-inch CRT monitor (Mitsubishi i-TECH IF700 CRT Monitor) with a spatial resolution of 1024 x 768 pixels and a refresh rate of 85 Hz. A viewing distance of approximately 65 cm was maintained. The participants were instructed to associate a shape with a role. One-third of participants associated ‘you’ with a disc, ‘friend’ with a square and ‘stranger’ with a triangle. Another third of participants associated ‘you’ with a triangle, ‘friend’ with a disc and ‘stranger’ with a square. The final third associated ‘you’ with a square, ‘friend’ with a triangle and ‘stranger’ with a disc. The task started with ten practice trials. Each trial began with an instruction display telling participants that they must press the space bar to begin, how many trials they had completed and the matching rules for the task (Fig. 3). Then, the fixation display—a white cross in which each arm had 1.76 degrees of visual angle was presented in the middle of a grey background—was presented for 506 ms. This was followed by the target display for 106 ms. In this display, the fixation cross was in the middle and a geometrical pattern was placed 3.5 degrees above the screen centre. The pattern could be a square with sides of 3.8 degrees of visual angle, a triangle with sides of 3.8 degrees of visual angle or a disc with the diameter of 3.8 degrees of visual angle. The words ‘you’, ‘friend’ or ‘stranger’ (written in Chinese) were placed 3.5 degrees below the screen centre. Next came the response display, which told participants to press the ‘y’ key to indicate correct matching or the ‘n’ key to indicate incorrect matching. Following this, the feedback display was presented for 506 ms. If the participant made a correct response within 2 seconds, ‘correct’ was shown in the middle of the screen. If the participant made an incorrect response within 2 seconds, ‘incorrect’ was shown in the middle of the screen and a 800-Hz tone was played for 100 ms. If the participant did not make any response within 2 seconds, a message reminding them of the 2-second maximum reaction time was shown in the middle of the screen with a 800-Hz tone played for 100 ms. Then came the instruction display for the next trial. The participants pressed any key to initiate the next trial. For a visualisation of this procedure, please refer to Fig. 3.

After 10 practice trials, the participants started the main task. They completed 72 trials at their own pace, and then they were shown a display telling them to stop. Next, they were directed to the questionnaire computer (Fig. 2) to answer six questions for each of the three videos they had watched prior to the role–shape matching task. Among the six questions, two were descriptions that had been provided in the video, so the correct answer was yes; two were descriptions that had not been provided in the video, so the correct answer was no; and the remaining two were critical questions, which were the same as the misleading questions in pre-test 2 (e.g. *'how old was the boy in the video? [10/8]*). One of the two critical questions was the easy question (low level of difficulty), and the other was hard (high level of difficulty). The six questions marked the end of one cycle (video watching and summarisation, emotion rating, misinformation feeding, role–shape matching, questions).

Each participant had to complete four cycles. For half of the participants, the first two cycles included videos that provoked a high degree of empathy, and the last two included videos that provoked a low degree of empathy. For the other half, the order was reversed. Therefore, the presentation order of the high empathy-inducing videos and the low empathy-inducing videos was counterbalanced. The descriptions about the videos and the questions used in the experiment are provided in Appendix.

It should also be noted that the 288 trials (72 per cycle) of role–shape matching task contained 96 trials for each shape (disc, triangle, or square). Each shape was paired with the matching role (me, friend, or stranger) in 48 trials and non-matching roles in 48 trials (24 for each of the other two). The trials of different conditions were randomised for each participant.

Data analysis for the role-shape matching task

The index of participants' capacity to discriminate a matched role–shape pair from a non-matched one, *d'*, was calculated based on the hit rate, which referred to the proportion of correct responses for matching trials, and false alarm rate, which referred to the proportion of incorrect responses for non-matching trials, according to the following formula:

$d' = \Phi^{-1}(H) - \Phi^{-1}(F)$

The inverse Gaussian function, Φ^{-1}, converts the hit rate ($\Phi^{-1}[H]$), and the false alarm rate ($\Phi^{-1}[F]$), into *z* scores. To avoid infinite numbers, any hit rate or false alarm rate of 100% or 0 was adjusted respectively [60] to (n-0.5)/n or 0.5/n, where n was the number of trials in each condition, and was 48 for the present study.

Declarations

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Acknowledgement

This work was supported by the Ministry of Science and Technology, Taiwan (grant number: MOST 108-2628-H-009 -001 -MY2 to SYL). We thank Yi-Shiu Lin, Chih-Yuan Lai, Shih-Chang Yu, Sih-Han Chen, Chia-Chin Yu and Chun-Ze Chou for their help with data collection.

Author Contribution Statement

The author SYL conceived this study, designed the experiment, analysed the data, and wrote the whole manuscript.

Competing Interests Statement

The author declares no competing interests.

References

1 Batson, C. D. *et al.* Empathy and attitudes: can feeling for a member of a stigmatized group improve feelings toward the group? *Journal of Personality and Social Psychology* **72**, 105-118 (1997).

2 Eisenberg, N., Fabes, R. A., Nyman, M., Bernzweig, J. & Pinuelas, A. The relations of emotionality and regulation to children's anger-related reactions. *Child Dev* **65**, 109-128 (1994).

3 Klimecki, O. M., Mayer, S. V., Jusyte, A., Scheeff, J. & Schonenberg, M. Empathy promotes altruistic behavior in economic interactions. *Scientific Reports* **6**, 31961, doi:10.1038/srep31961 (2016).

4 Batson, C. D. *et al.* Is empathy-induced helping due to self–other merging? *Journal of personality and social psychology* **73**, 495-509 (1997).

5 Aron, A., Aron, E. N. & Smollan, D. Inclusion of other in the self scale and the structure of interpersonal closeness. . *Journal of personality and social psychology* **63**, 596-612 (1992).

6 Aron, A., Aron, E. N., Tudor, M. & Nelson, G. Close relationships as including other in the self. . *Journal of personality and social psychology* **60**, 241-253 (1991).

7 Keenan, J. P. *et al.* Left hand advantage in a self-face recognition task. *Neuropsychologia* **37**, 1421-1425 (1999).

8 Sui, J., Chechlacz, M. & Humphreys, G. W. Dividing the self: distinct neural substrates of task-based and automatic self-prioritization after brain damage. *Cognition* **122**, 150-162, doi:10.1016/j.cognition.2011.10.008 (2012).

9 Sui, J., Liu, C. H. & Han, S. Cultural difference in neural mechanisms of self-recognition. *Soc Neurosci* **4**, 402-411, doi:10.1080/17470910802674825 (2009).

10 Bredart, S., Delchambre, M. & Laureys, S. One's own face is hard to ignore. . *Quarterly Journal of Experimental Psychology* **59**, 46–52, doi:10.1080/17470210500343678 (2006).

11 Gronau, N., Cohen, A. & Ben-Shakhar, G. Dissociations of personally significant and task-relevant distractors inside and outside the focus of attention: A combined behavioral and psychophysiological study. *Journal of Experimental Psychology: General* **132**, 512–529, doi:10.1037/0096-3445.132.4.512 (2003).

12 Sui, J., He, X. & Humphreys, G. W. Perceptual effects of social salience: Evidence from self-prioritization effects on perceptual matching. . *Journal of Experimental Psychology: Human Perception and Performance* **38**, 1105-1117 (2012).

13 Rogers, T. B., Kuiper, N. A. & Kirker, W. S. Self-reference and the encoding of personal information. *Journal of personality and social psychology* **35**, 677-688 (1977).

14 Cabeza, R. *et al.* Brain activity during episodic retrieval of autobiographical and laboratory events: an fMRI study using a novel photo paradigm. *Journal of cognitive neuroscience* **16**, 1583-1594 (2004).

15 Pohl, R. F., Bender, M. & Lachmann, G. Autobiographical memory and social skills of men and women. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition* **19**, 745-759 (2005).

16 Mandler, G. Recognizing: The judgment of previous occurrence. *Psychological Review* **87**, 252-271 (1980).

17 Tulving, E. How many memory systems are there? *American Psychologist* **40**, 385-398 (1985).

18 Yonelinas, A. P. Receiver-operating characteristics in recognition memory: evidence for a dual-process model. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **20**, 1341-1354 (1994).

19 Brainerd, C. J., Reyna, V. & Kneer, R. False-recognition reversal: When similarity is distinctive. *Journal of Memory and Language* **34**, 157-185 (1995).

20 Reyna, V. F., Wilhelms, E. A., McCormick, M. J. & Weldon, R. B. Development of risky decision making: Fuzzy-trace theory and neurobiological perspectives. *Child development perspectives* **9**, 122-127 (2015).

21 Reyna, V. F., Corbin, J. C., Weldon, R. B. & Brainerd, C. J. How fuzzy-trace theory predicts true and false memories for words, sentences, and narratives. *Journal of applied research in memory and cognition* **5**, 1-9 (2016).

22 Brainerd, C. J., Wright, R., Reyna, V. & Mojardin, A. Conjoint recognition and phantom recollection. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **27**, 307-327 (2001).

23 Roediger, H. L., Watson, J. M., McDermott, K. B. & Gallo, D. A. Factors that determine false recall: A multiple regression analysis. *Psychonomic bulletin & review* **8**, 385-407 (2001).

24 Frenda, S. J., Nichols, R. M. & Loftus, E. F. Current issues and advances in misinformation research. . *Current Directions in Psychological Science* **20**, 20–23, doi:10.1177/0963721410396620 (2011).

25 Loftus, E. F. Planting misinformation in the human mind: A 30-year investigation of the malleability of memory. *Learning & Memory* **12**, 361–366, doi:10.1101/lm.94705 (2005).

26 Loftus, E. F. The malleability of human memory. *American Scientist* **67**, 312–320 (1979).

27 Loftus, E. F., Donders, K., Hoffman, H. G. & Schooler, J. W. Creating new memories that are quickly accessed and confidently held. *Memory & Cognition* **17**, 607–616, doi:10.3758/BF03197083 (1989).

28 Loftus, E. F., Miller, D. G. & Burns, H. J. Semantic integration of verbal information into a visual memory. *Journal of Experimental Psychology: Human Learning and Memory* **4**, 19–31, doi:10.1037/02787393.4.1.19 (1978).

29 Nourkova, V., Bernstein, D. M. & Loftus, E. F. Altering traumatic memory. *Cognition and Emotion* **18**, 575–585, doi:10.1080/02699930341000455 (2004).

30 Okado, Y. & Stark, C. E. L. Neural activity during encoding predicts false memories created by misinformation. *Learning & Memory* **12**, 3–11, doi:10.1101/lm.87605 (2005).

31 Takarangi, M. K. T., Parker, S. & Garry, M. Modernising the misinformation effect: The development of a new stimulus set. *Applied Cognitive Psychology* **20**, 583–590, doi:10.1002/acp.1209 (2006).

32 Van Damme, I. & Smets, K. The power of emotion versus the power of suggestion: memory for emotional events in the misinformation paradigm. *Emotion* **14**, 310-320, doi:10.1037/a0034629 (2014).

33 Adolphs, R., Denburg, N. L. & Tranel, D. The amygdala's role in long-term declarative memory for gist and detail. *Behavioral Neuroscience* **115**, 983-992 (2001).

34 Brown, J. M. Eyewitness memory for arousing events: Putting things into context. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition* **17**, 93-106 (2003).

35 Russell, J. A. A circumplex model of affect. *Journal of Personality and Social Psychology* **39**, 1161-1178 (1980).

36 Brainerd, C. J. & Reyna, V. F. *The science of false memory*. (Oxford University Press, 2005).

37 Beadle, J. N., Tranel, D., Cohen, N. J. & Duff, M. Empathy in hippocampal amnesia. *Frontiers in psychology* **4**, 69 (2013).

38 Wagner, U., Handke, L. & Walter, H. The relationship between trait empathy and memory formation for social vs. non-social information. *BMC psychology* **3**, 2 (2015).

39 Decety, J. & Svetlova, M. Putting together phylogenetic and ontogenetic perspectives on empathy. *Developmental cognitive neuroscience* **2**, 1-24 (2012).

40 Dondi, M., Simion, F. & Caltran, G. Can newborns discriminate between their own cry and the cry of another newborn infant? *Developmental psychology* **35**, 418-426 (1999).

41 Bartal, I. B.-A., Decety, J. & Mason, P. Empathy and pro-social behavior in rats. *Science* **334**, 1427-1430 (2011).

42 Decety, J. Perspective taking as the royal avenue to empathy. *Other minds: How humans bridge the divide between self and others*, 143-157 (2005).

43 Decety, J. & Jackson, P. L. The functional architecture of human empathy. *Behavioral and cognitive neuroscience reviews* **3**, 71-100 (2004).

44 Decety, J. & Meyer, M. From emotion resonance to empathic understanding: A social developmental neuroscience account. *Development and psychopathology* **20**, 1053-1080 (2008).

45 Decety, J. & Moriguchi, Y. The empathic brain and its dysfunction in psychiatric populations: Implications for intervention across different clinical conditions. *BioPsychoSocial medicine* **1**, 1-21 (2007).

46 Decety, J. Dissecting the neural mechanisms mediating empathy. *Emotion review* **3**, 92-108 (2011).

47 Kuypers, K. P. Context-dependent emotional empathy in virtual reality. *Advances in Social Sciences Research Journal* **5**, 379-392 (2018).

48 Kensinger, E. A. & Corkin, S. Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Journal of Memory and Cognition* **31**, 1169-1180 (2003).

49 Ochsner, K. N. Are affective events richly recollected or simply familiar? The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General* **129**, 242-261 (2000).

50 Sharot, T. & Phelps, E. A. How arousal modulates memory: Disentangling the effects of attention and retention. *Journal of Cognitive, Affective, and Behavioral Neuroscience* **4**, 294-306 (2004).

51 Lo, S.-Y. & Wang, Y.-S. Bad words prevail: Negatively charged Chinese characters accelerate attentional selection and preoccupy cognitive resources for consolidation. *Attention, Perception, and Psychophysics* **81**, 2814-2831 (2019).

52 Loftus, E. F. J. L. & memory. Planting misinformation in the human mind: A 30-year investigation of the malleability of memory. **12**, 361-366 (2005).

53 Biddlestone, M., Green, R. & Douglas, K. J. B. J. o. S. P. Cultural orientation, powerlessness, belief in conspiracy theories, and intentions to reduce the spread of COVID-19. (2020).

54 Eisenberg, N. & Miller, P. A. The relation of empathy to prosocial and related behaviors. *Psychological Bulletin* **101**, 91-119 (1987).

55 Faul, F., Erdfelder, E., Lang, A.-G. & Buchner, A. G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods* **39**, 175-191 (2007).

56 Klimecki, O. M., Leiberg, S., Lamm, C. & Singer, T. Functional neural plasticity and associated changes in positive affect after compassion training. *Cereb Cortex* **23**, 1552-1561, doi:10.1093/cercor/bhs142 (2013).

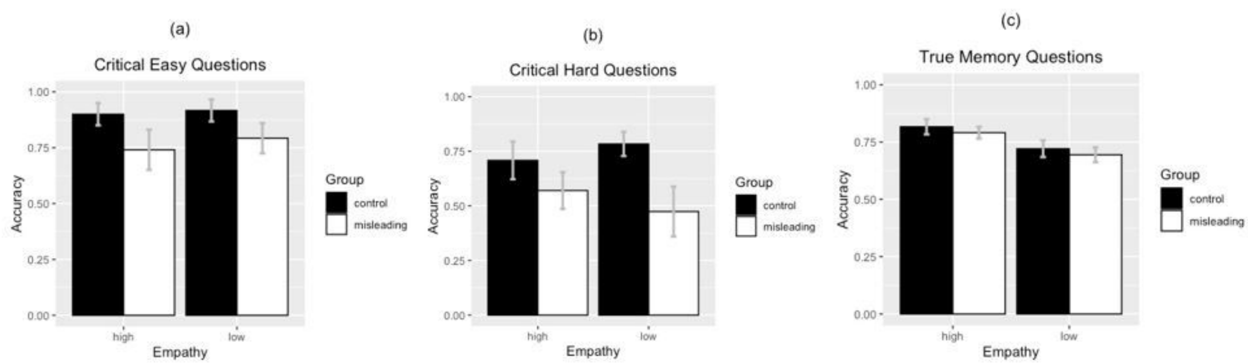
57 Davis, M. H. Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of personality and social psychology* **44**, 113-126 (1983).

58 Brainard, D. H. The Psychophysics Toolbox. *Spatial Vision* **10**, 433-436 (1997).

59 Pelli, D. G. The VideoToolbox software for visual psychophysics: transforming numbers into movies. *Spatial Vision* **10**, 437-442 (1997).

60 Macmillan, N. A. & Kaplan, H. L. Detection theory analysis of group data: Estimating sensitivity from average hit and false-alarm rates. . *Psychological Bulletin* **98**, 185-199 (1985).

Figures



Note. There figures show memory performance for (a) critical easy, (b) critical hard, and (c) true-memory questions. The error bars indicate the 95% confidence interval.

Figure 1

The Accuracy of Memory Performance

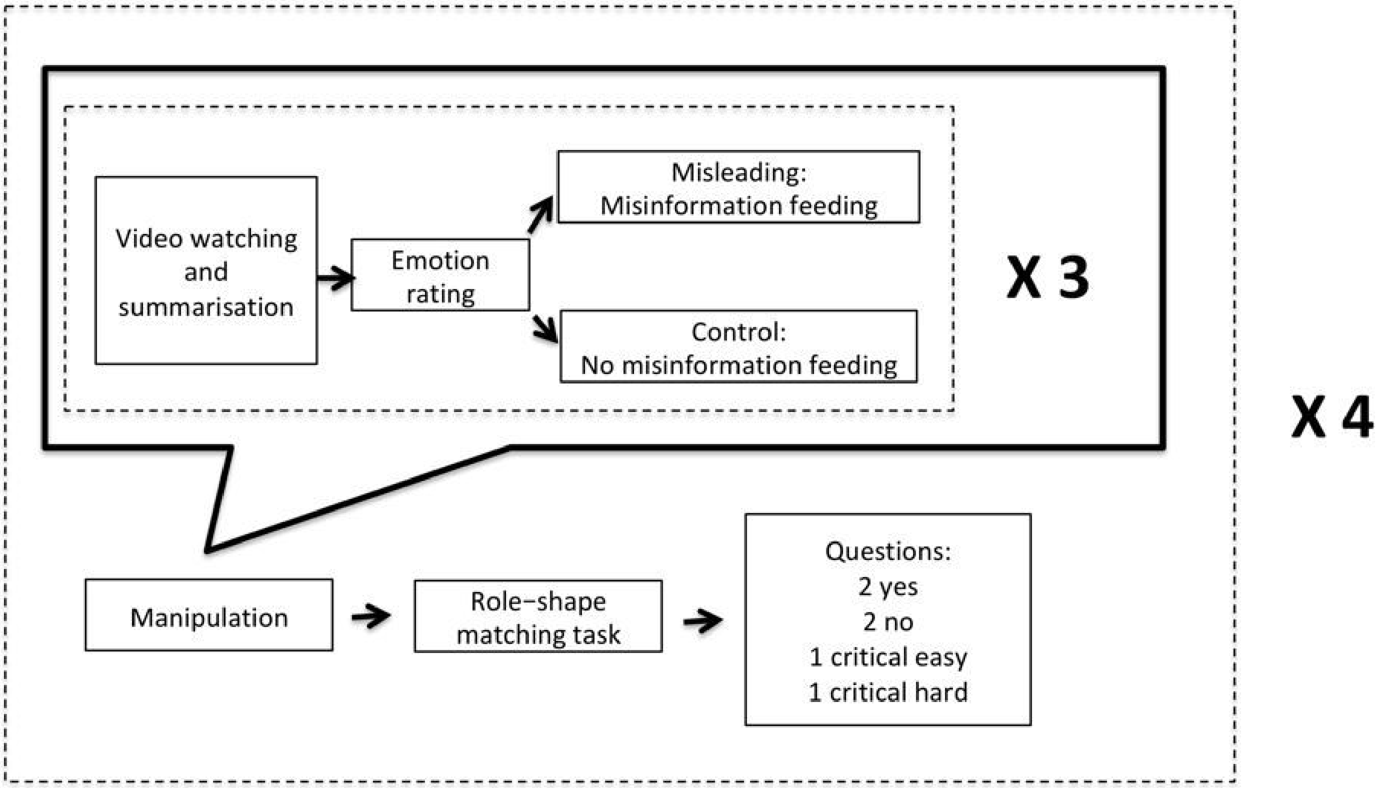


Figure 2

The Structure of the Experimental Procedure

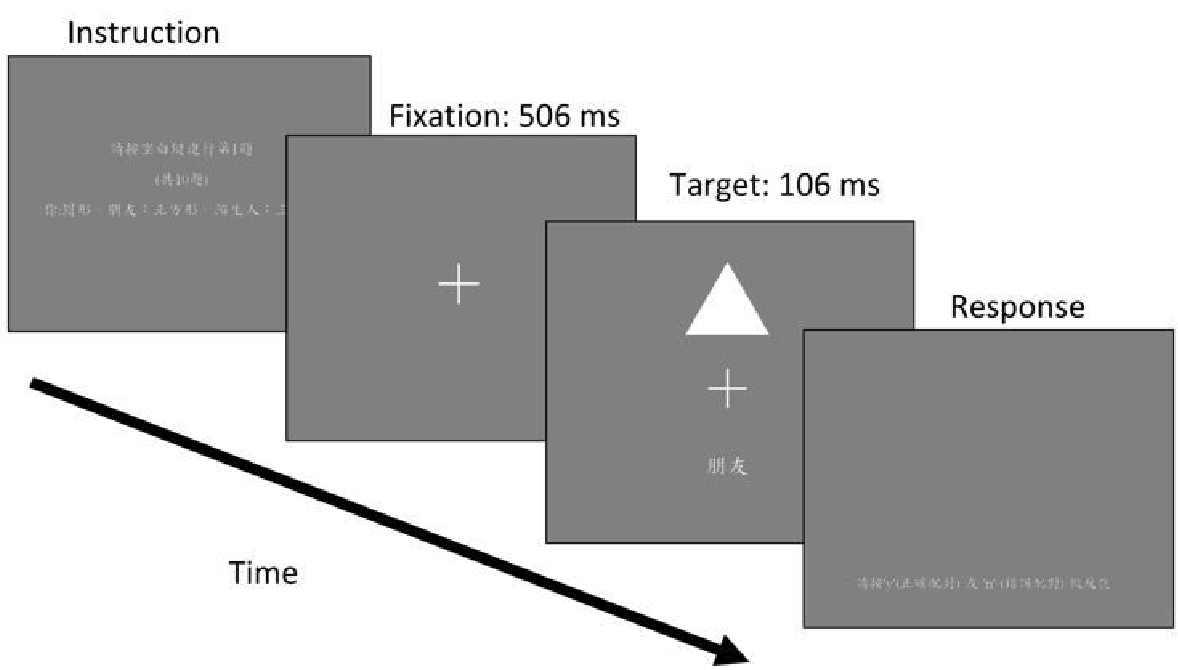


Figure 3

Stimulus Sequence of the Role-shape Matching Task. Note. The three lines in the instruction display are translated as ‘Please press space bar to proceed to Trial 1’, ‘(10 trials in total)’ and ‘You: Disc; Friend: Square; Stranger: Triangle’. The word shown in this example target display is ‘friend’. In the response display, the message can be translated as ‘please press “y” (correct) or “n” (incorrect) to respond’. In the actual experiment, the response display was followed by a feedback display, where ‘correct’ or ‘incorrect’ was printed in the centre of the display. The ‘incorrect’ feedback display was accompanied with a tone.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix.pdf