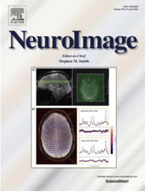
NeuroImage 270 (2023) 119957

Contents lists available at ScienceDirect

NeuroImage

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



The single- and dual-brain mechanisms underlying the adviser's confidence expression strategy switching during influence management

Enhui Xie[a], Mengdie Liu[a], Keshuang Li[a], Samuel A. Nastase[e], Xiaoxue Gao[b,*], Xianchun Li[a,c,d,*]

[a] *Shanghai Key Laboratory of Mental Health and Psychological Crisis Intervention, Affiliated Mental Health Center (ECNU), School of Psychology and Cognitive Science, East China Normal University, Shanghai, 200062, China*
[b] *Shanghai Key Laboratory of Mental Health and Psychological Crisis Intervention, School of Psychology and Cognitive Science, East China Normal University, Shanghai, 200062, China*
[c] *Shanghai Changning Mental Health Center, Shanghai, China, 200335*
[d] *Institute of Wisdom in China, East China Normal University, Shanghai, China, 200062*
[e] *Princeton Neuroscience Institute, Princeton University, Princeton, NJ, 08544, United States*

ARTICLE INFO

Keywords:
Advice-giving strategy
Strategy switching
Single-brain
Dual-brain
Functional near-infrared spectroscopy (fNIRS)

ABSTRACT

Effective influence management during advice-giving requires individuals to express confidence in the advice properly and switch timely between the 'competitive' strategy and the 'defensive' strategy. However, how advisers switch between these two strategies, and whether and why there exist individual differences during this process remain elusive. We used an advice-giving game that manipulated incentive contexts (Incentivized/Non-Incentivized) to induce the adviser's confidence expression strategy switching and measured the brain activities of adviser and advisee concurrently using functional near-infrared spectroscopy (fNIRS). Behaviorally, we observed individual differences in strategy switching. Some advisers applied the 'defensive' strategy when incentivized and the 'competitive' strategy when not incentivized, while others applied the 'competitive' strategy when incentivized and the 'defensive' strategy when not incentivized. This effect was mediated by the adviser's perceived stress in each condition and was reflected by the frequencies of advice-taking in the advisees. Neurally, brain activation in the dorsolateral prefrontal cortex (DLPFC) supported strategy switching, as well as interpersonal neural synchronization (INS) in the temporoparietal junction (TPJ) that supported influence management. This two-in-one process, i.e., confidence expression strategy switching and the corresponding influence management, was linked and modulated by the strength of DLPFC-TPJ functional connectivity in the adviser. We further developed a descriptive model that contributed to understanding the adviser's strategy switching during influence management.

1. Introduction

Imagine you are in a clothing shop, and your friends ask you which dress they should buy. Assuming you're not sure how to engage in influencing your friend's choice, it is clear that you would modulate your confidence in your advice. Then, would you express your advice with higher confidence or lower confidence when your friends accept your advice previously? Would you express your advice with higher confidence or lower confidence when your friends reject your advice previously? Giving advice and expressing confidence in the advice properly is crucial for individuals to maintain social influence (Bayarri and Degroot, 1989; Hertz et al., 2017), which has been widely observed in social life navigations, such as good selling (Hamby et al., 2015), election canvassing (Barton et al., 2014), and legal defense (Helm et al., 2018; Toro, 1986). Research has proposed two confidence expression strategies that individuals commonly apply to influence others and gain popularity among people (Bayarri, and DeGroot, 1989; Hertz et al., 2017; Tenney et al., 2007): advisers who report higher confidence when ignored by the advisees and report lower confidence when chosen by the advisees are considered to be applying the 'competitive' strategies, while those who report lower confidence when ignored by the advisees and report higher confidence when chosen by the advisees are applying the 'defensive' strategies (Gilbert, 2000; Price et al., 1994; Tetlock, 2017). Instead of applying one strategy constantly, individuals may flexibly switch advising strategies between two strategies to facilitate social influence, as inspired by evidence of the context-dependent nature of human decision-making in both economics (Feldmanhall et al., 2018; Heffner and FeldmanHall, 2019; Hill et al., 2017; Park et al., 2019) and moral domains (Tenney et al., 2007; van Baar et al., 2019). Despite the ubiquity of advice-giving and the adviser's confidence expression strategy switching

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* Correspondence to: School of Psychology and Cognitive Science, East China Normal University, Shanghai, China.
E-mail addresses: gxx114455@gmail.com (X. Gao), xcli@psy.ecnu.edu.cn (X. Li).

https://doi.org/10.1016/j.neuroimage.2023.119957.
Received 1 January 2023; Received in revised form 11 February 2023; Accepted 18 February 2023

behaviors in daily life (e.g., in management, judicial and political fields) (Ajzen and Fishbein, 1977; Sah et al., 2013), very little is known about the psychological and neural mechanisms underlying how an adviser switches between the two strategies to manage influence and whether and why there exist individual differences in this process.

First, previous studies have suggested that incentive contexts may induce the adviser's confidence expression strategy switching, and the adviser's perceived stress regarding the advice may be an important mediating psychological component during this process (Leder et al., 2013; Sidarus et al., 2019; Smith, and Szidarovszky, 2003). For example, it has been that individuals' strategic behaviors are commonly motivated by gaining rewards and avoiding punishment (Baumert and Emmrich, 2001; Hampton et al., 2008; Mobbs et al., 2009). Compared with individuals with lower incentive expectations, individuals with higher incentive expectations take more account of their opponents' intentions and actions when applying strategies to exert influence on the opponents (King-Casas et al., 2005; Lefebvre, and Stenger, 2020). Moreover, perceived stress might play a crucial role in the effect of incentives on strategy switching (Bonus, 2016; Elman et al., 2009; Sah et al., 2013). Research has shown that stress regarding advice may impact strategy switching in influence management, including moral strategic decision-making (Speer et al., 2020; Starcke, and Brand, 2012), economic strategic decision-making (Bonus, 2016; Leder et al., 2013, 2015) and coping strategic decision-making (Fisher, 2015). When advisers are incentivized, they undertake the consequences of rejection by advisees as well as the loss of their interests, thereby they will perceive more stress (Elman et al., 2009; Sah et al., 2013). In this view, this enhanced stress may cause advisers to report lower confidence when rejected by the advisees while reporting higher confidence when chosen by the advisees (i.e., the 'defensive' strategy). Contrarily, when advisers are not incentivized and receive a fixed income, they may perceive less stress (Elman et al., 2009; Hopper et al., 2008), and dare to report higher confidence when rejected by the advisees while reporting lower confidence when chosen by the advisees (the 'competitive' strategy). Therefore, the current study applied incentive contexts (Incentivized vs. Non-Incentivized) in an advice-giving interactive game to induce the adviser's confidence expression strategy switching between contexts. Moreover, the current study tested how incentives induced an adviser's strategy switching and the role of perceived stress in this process.

Second, evidence on the individual differences in strategic decision-making (Bruine de Bruin, Parker, and Fischhoff, 2007; Schilit, 1986; Scheres, and Sanfey, 2006) and stress perception during social interactions (Bonus, 2016; Leder et al., 2015; Speer et al., 2020; Starcke, and Brand, 2012) suggest the potential individual differences in the adviser's confidence expression strategy switching. From the perspective of strategic decision-making, several lines of research have shown that people employed different principles to guide the application of strategies, which leads to individual differences in strategic decision-making (Heffner, and FeldmanHall, 2019; Kuhlman, and Marshello, 1975; Scheres, and Sanfey, 2006). From the perspective of stress perception, it has been shown that some people perceive less stress when exposed to aversive stimuli and appear to behave aggressively and impulsively, whereas others perceive more stress and appear to behave more cautiously and fearfully (Ebner, and Singewald, 2017; Clifford et al., 2022). Inspired by these two lines of evidence, we aimed to test whether there existed individual differences in adviser's confidence expression strategy switching and how it emerged at psychological and neural levels.

Finally, to systematically uncover the neural mechanisms underlying the adviser's strategy switching during influence management, we take advantage of technological innovations of fNIRS to simultaneously track 'individual' and 'two-person' brain activation. On the one hand, single-brain activation may provide a direct measure of neural processes in advisers during strategy switching (Hampton et al., 2008; Schwenk, 1988; Wout et al., 2005). Previous neuroscientific investigations have identified brain regions involved in moral and intergroup strategies such as the dorsolateral prefrontal cortex (DLPFC) (Van Baar et al., 2019; Yang et al., 2020). However, it is not yet known whether single-brain activation in the DLPFC was involved in the process of the adviser's confidence expression strategy switching. On the other hand, dual-brain interpersonal neural synchronization (INS) may provide a measure of neural processes during influence management in which advisers attempt to process information in a similar way to the advisee (Chen et al., 2020; Jiang et al., 2015; Liu et al., 2019). A growing number of studies have measured the neural similarity in processing information in natural interactions between two or more individuals using hyperscanning (Hirsch et al., 2018; Jiang et al., 2015; Noah et al., 2020). Previous neuroimaging studies have suggested that the right temporoparietal junction (TPJ) is implicated in mentalizing and updating beliefs about others, and the degree of INS in this region is closely related to interpersonal coordination (Frith and Frith, 2003; Hampton et al., 2008; Hertz et al., 2017; Van Baar, Halpern, and FeldmanHall, 2021). However, the role of the dual-brain INS in the TPJ in the process of advice-giving-induced influence management remains unclear. Therefore, the current study considered DLPFC and TPJ as regions of interest to reveal the single- and dual-brain neural mechanisms underlying the adviser's strategy switching during influence management.

To advance the understanding of the brain processes underlying advice-related interaction, it is necessary to measure and build the association between the adviser's and adviser-advisee dyad's brain activity concurrently (Frith, and Frith, 2012). However, the majority of advice-related research either focuses on single-brain activation or dual-brain INS findings independently. The latest research has identified the neural network changes in social decision-making included two aspects: decreased brain activation in brain areas (i.e., the DLPFC) and increased INS in brain areas (i.e., the TPJ) (Cheng et al., 2022), but it is unclear how single-brain activities and INS coordinate to drive social decision-making. Yang and colleagues (2020) propose that the increased DLPFC-TPJ connectivity allows for the functional integration of social information into the decision-making process. As such, we seek to unlock the neural mechanisms underlying the two-in-one process (i.e., confidence expression strategy switching and influence management) by examining whether and how the adviser's single-brain activation regulates the dual-brain INS of adviser-advisee dyads via DLPFC-TPJ functional connectivity.

In the present study, we randomly assigned pairs of participants to play the roles of advisers and advisees in an advice-giving game. Behaviorally, we sought to test how incentives induce an adviser's strategy switching, whether there existed individual differences, and the role of perceived stress in this process. Neurally, we sought to examine the single- and dual-brain mechanisms underlying the adviser's confidence expression strategy switching during influence management. We calculated two neural indices: single-brain activation in the adviser's brain and dual-brain INS of adviser-advisee dyads. We also tested how single-brain activation in the adviser's brain and dual-brain INS of adviser-advisee dyads coordinated to drive the adviser's strategy switching during influence management and whether this coordinated neural process was regulated via the adviser's functional connectivity in the brain. Finally, we developed a descriptive model that reveals the behavioral and neural mechanisms of the adviser's incentive-induced strategy switching during influence management by integrating behavioral, single-brain neuroimaging, and dual-brain neuroimaging results.

2. Materials and methods

2.1. Participants

Sixty-eight Chinese students (34 pairs, 35% males, mean age ± SD = 20.88 ± 1.96 years) were recruited as same-gender, unfamiliar pairs and were then randomly assigned to play the roles of adviser and advisee in the present study. The sample size was estimated us-

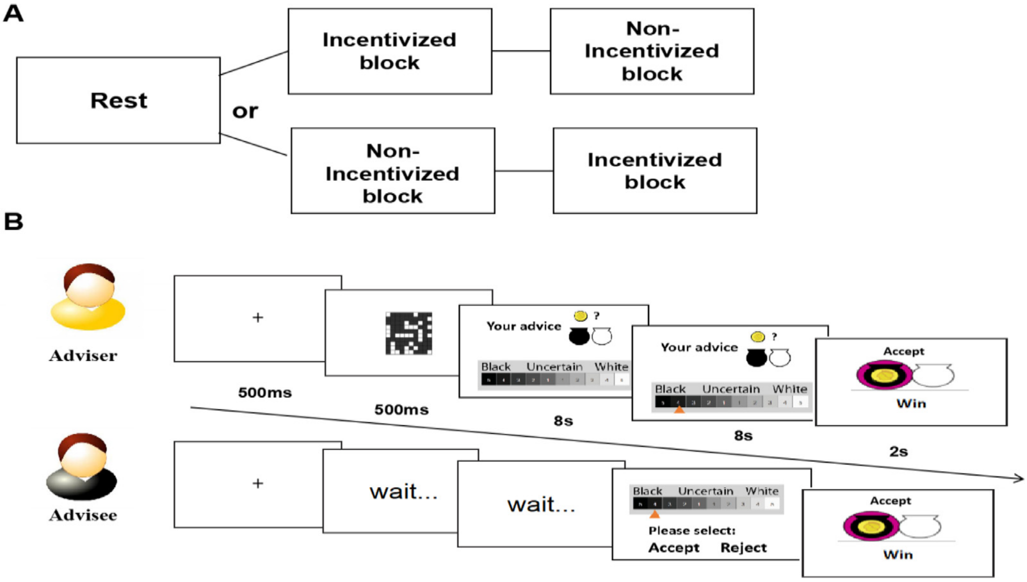

Fig. 1. Experimental procedure of an advice-giving interaction. (A) Three sessions in the experiment for each adviser-advisee pair: Rest, Incentivized block, and Non-Incentivized block (the order of Incentivized and Non-Incentivized blocks were counterbalanced across pairs). In the Incentivized condition, the advisers would gain 10 points as a reward (exchanged for 0.5 RMB) when the advisees accepted the advice and would lose 10 points as a punishment (exchanged for 0.5 RMB) when the advisees rejected the advice. In contrast, in the Non-Incentivized condition, there was no reward or punishment no matter whether the advisee accepted the advice or not. (B) In the revised advice-giving task, each trial contained an evidence stage, advice-giving stage, showdown stage, and outcome stage. In the evidence stage, the advisers accessed additional information regarding the probability of the coin's location in this stage. Then the advisers advised on the location of the coin using a 10-level confidence scale ranging from 'definitely in the black urn' to 'definitely in the white urn'. Next, the advisees saw the advisers' advice and current confidence and considered whether to accept the advice or not. Finally, the selection of the advisee was revealed and the content of the urn indicated by the adviser's advice was revealed to both the adviser and the advisee.

ing G*Power (Faul et al., 2007) with a middle effect size (dz) of 0.5 (Beck, 2013), results indicated that thirty-four dyads were needed to detect a reliable effect with $\alpha = 0.05$, $\beta = 0.80$ for a paired-sample *t*-test. All participants had normal or corrected-to-normal vision and reported no history of neurological or psychiatric diagnoses. All participants wrote informed consent after the experimental procedure had been fully explained. Participants were reminded of their right to withdraw at any time during the study. The study had full ethical approval by the University Committee on Human Research Protection (HR 525–2020), East China Normal University.

In the current study, each pair of participants completed a revised advice-giving task (Fig. 1B), which was adopted from a previous interactive task on advice-giving (Hertz et al., 2017). The adviser received additional information regarding a mini game, gave their advice to the advisee, and expressed their confidence in the advice, and ultimately the advisee could decide whether to accept the advice or not. We manipulated the incentive contexts (Incentivized vs. Non-Incentivized) as a within-subject variable in the experiment. The study included two blocks of 36 trials. Each of the Incentivized and the Non-Incentivized conditions consisted of one block, and the order of the two blocks was counterbalanced across pairs (Fig. 1A). In the Incentivized condition, the advisers would gain 10 points as a reward (exchanged for 0.5 RMB) when the advisees accepted the advice and would lose 10 points as a punishment (exchanged for 0.5 RMB) when the advisees rejected the advice. In contrast, in the Non-Incentivized condition, there was no reward or punishment no matter whether the advisee accepted the advice or not. As such, in order to be more accepted by advisees, the advisers needed to switch their confidence expression strategies to maximize their influence. As for the advisees, they knew whether the advisers had further incentives, and they received fixed monetary compensation in both conditions. The adviser's influence management was reflected by the frequency that the advisees accepted the advice.

Participants arrived at the fNIRS lab and have a 3-min rest (Fig. 1A). After the rest, the participants engaged in the revised advice-giving task (Fig. 1B). The advisers needed to help the advisees to look for a coin hidden in a black or white urn by giving advice and their confidence in the advice. Each trial contained four stages. First, the evidence stage lasted 500 ms, and the advisers accessed additional information regarding the probability of the coin location in this stage. To increase the differences between the confidence expressed by the adviser's advice and the probability expressed by the evidence, we divided the evidence into four levels of choosing a black urn (0.4/0.6, 0.6/0.4, 0.8/0.2, 0.2/0.8). In 80% of the trials, the evidence indicated an ambiguous probability of choosing the black urn (i.e., 0.4/0.6, 0.6/0.4), so that we could better discriminate what the adviser's strategy was, which was more likely to be affected by our manipulated contexts rather than simply guided by evidence. In 10% of the trials, the evidence indicated an 0.8 probability of choosing a black urn, and in the remaining 10% of the trials, the evidence indicated an 0.2 probability of choosing a black urn. Second, the advice-giving stage lasted 8 s: the advisers advised on the location of the coin using a 10-level confidence scale ranging from 'definitely in the black urn' to 'definitely in the white urn'. Third, the showdown stage lasted 8 s: the advisees saw the advisers' advice and confidence and considered whether to accept the advice or not. Fourth, the outcome stage lasted 2 s: the selection of the advisee was revealed and the content of the urn indicated by the adviser's advice was revealed to both the adviser and the advisee.

In addition, we assessed each adviser's self-reported perceived stress using one item, adapting from previous research (Arapovic-Johansson et al., 2017). The items read, "Right now, I am stressed out regarding giving advice" after the Incentivized block and the Non-Incentivized block, respectively. Rating scales ranged from 0 (strongly disagree) to 50 (strongly agree).

2.2. Neuroimaging data acquisition

The brain activities of both participants in each pair were simultaneously recorded with fNIRS using an ETG-7100 optical topography

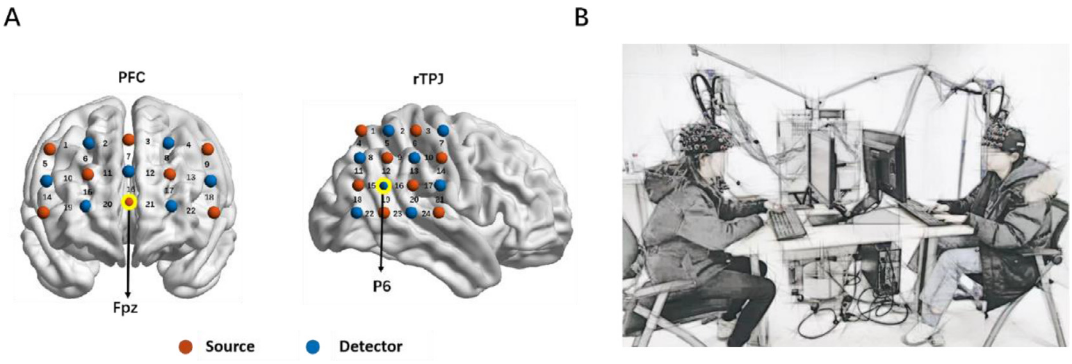

Fig. 2. Probe location and measure the brain activity simultaneously. (A) Optode probe sets. The sets were placed over the prefrontal and right temporoparietal regions. (B) During the interaction, individual neural activity was recorded using fNIRS.

system (Hitachi Medical Corporation, Japan). The absorption of near-infrared light (two wavelengths: 695 and 830 nm) is measured with a sampling rate of 10 Hz. The oxyhemoglobin (HbO) and deoxyhemoglobin (HbR) are obtained under the modified Beer-Lambert law, and the patterns of related results remained the same as HbO after conducting the analyses on HbR (see details in the supplementary materials). However, our interpretation of results was based on HbO signals for the following reasons: (i) HbO concentration is sensitive to changes in regional cerebral blood flow (Hoshi, 2003); (ii) the HbO signal was reported to have a higher signal-to-noise ratio than the HbR signal (Mahmoudzadeh et al., 2013); and (iii) an increasing number of studies have revealed single-brain activation and neural synchronization based on the HbO signal (e.g., Liu et al., 2019; Xie et al., 2022).

Two optode probe sets were used to cover each participant's prefrontal and right TPJ regions (Fig. 2A), which have been previously reported to be associated with strategic advice during advice-related interaction (Crum et al., 2022; Hertz et al., 2017; Van Baar et al., 2019). For each participant, one 3 × 5 optode probe set (eight emitters and seven detectors forming 22 measurement points with 3 cm optode separation, see Table S1 for detailed MNI coordinates) was placed over the prefrontal cortex (reference optode is placed at Fpz). The other 4 × 4 probe set (eight emitters and eight detectors forming 24 measurement points with 3 cm optode separation) was placed over the right temporoparietal regions (reference optode is placed at P6, see Table S2 for detailed MNI coordinates). The probe sets were examined and adjusted to ensure consistency of the positions across the participants (Fig. 2B).

2.3. Behavioral data analyses

Overview. Behaviorally, 1) we sought to test how the adviser switched confidence expression strategy in the manipulation of incentive contexts by comparing the strategies in the Incentivized and the Non-Incentivized conditions. 2) We sought to test whether there were individual differences in strategy switching during influence management. We plotted each adviser's strategies under different conditions. 3) We conducted the correlation between the frequency of advice acceptance and selection parameters to test how strategy switching modulated the effectiveness of influence management. 4) We tested whether perceived stress mediated the effect of the incentive contexts on the advisers' strategies with individual differences.

To assess the advising strategy in each condition, we calculated advice deviance and the $\beta_{\text{selection}}$ coefficient. First, we calculated trial-by-trial advice deviance. Advice deviance was the difference between the advice confidence and the probability indicated by the evidence. We then estimated the $\beta_{\text{selection}}$ coefficient by conducting the linear mixed model regression which was adapted from Hertz et al. (2017) (Eq. (1)). Eq. (1) took advice deviance as the dependent variable and the selection by the advisee from the previous trial as the fixed effect (Ignored = −1, Chosen = 1). Moreover, random intercepts and slopes for participants were estimated, with $\beta_{\text{selection}}$ being the random slope for each participant.

$$\text{AdviceDeviance}_{(t)} \sim \text{Selection}_{(t-1)} + (1 + \text{Selection}_{(t-1)}|\text{Sub}) \tag{1}$$

Positive values of $\beta_{\text{selection}}$ corresponded to the 'defensive' strategy, i.e., advisers reported negative deviance advice when they were ignored by their advisees and positive deviance advice when they were chosen by their advisees. Conversely, negative values of $\beta_{\text{selection}}$ corresponded to the 'competitive' strategy, i.e., advisers reported positive deviance advice when they were ignored by their advisees and negative deviance advice when they were chosen by their advisees.

First, to address the question of how the adviser switched confidence expression strategy in the manipulation of incentive contexts, we conducted one-sample *t*-tests and a paired-sample *t*-test for $\beta_{\text{selection}}$ across incentive contexts (Incentivized vs. Non-Incentivized). Second, to test whether there were individual differences in strategy switching during influence management, we plotted each adviser's $\beta_{\text{selection}}$ under different incentive conditions. We then overserved the individual differences in strategy switching. Some advisers applied the 'defensive' strategy in the Incentivized condition (i.e., the advisers' $\beta_{\text{selection}} > 0$) while applying the 'competitive' strategy in the Non-Incentivized condition (i.e., the advisers' $\beta_{\text{selection}} < 0$), while some advisers who applied the 'competitive' strategy in the Incentivized condition while applying the 'defensive' strategy in the Non-Incentivized condition. Third, to test how the individual differences in strategy switching modulated the effectiveness of influence management, we computed the average acceptance rate of each adviser-advisee dyad in the whole experiment and then conducted the correlation between the average acceptance rates and the difference in $\beta_{\text{selection}}$ ($\Delta\beta_{\text{selection}}$). Specifically, $\Delta\beta_{\text{selection}} = \beta_{\text{selection}}$ in the Incentivized condition − $\beta_{\text{selection}}$ in the Non-Incentivized condition.

Next, we sought to address the question of why there were individual differences in strategy switching. We first conducted a regression analysis, with incentive contexts, self-reported perceived stress, and their interaction effect as the independent variables, and $\beta_{selection}$ as the dependent variable. We then used PROCESS model 6 with 5000 bootstraps resamples (Preacher, and Hayes, 2008) to examine whether perceived stress mediated the effect of incentive-induced strategy switching with individual differences on influence management.

In addition, we conducted a follow-up experiment in a larger sample to assess whether our results could be replicated and extended.

2.4. fNIRS data analyses

Overview. Neurally, we sought to examine the single- and dual-brain mechanisms underlying the confidence expression strategy switching during influence management. 1) We sought to examine whether the process of the adviser's confidence expression strategy switching was reflected in the adviser's single-brain activation. We examined the neural substrates shared by the 'defensive' and the 'competitive' strategies and expected that overlapping regions involved in the two strategies were responsible for strategy switching. We then examined whether individual differences in strategy switching were reflected in the single-brain activation. Finally, we tested whether perceived stress and brain activation mediated the effect of incentive contexts on the adviser's strategies. 2) We sought to examine whether the influence management induced by adviser's strategy switching was reflected in distinct dual-brain INS. We first identified task-related INS during the adviser-advisee interaction. We then examined whether individual differences in strategy switching were reflected in the dual-brain INS by conducting correlation analysis and mediation analysis. 3) Given that the advisers' strategy switching during influence management unfolds as a two-in-one process (i.e., the adviser's confidence expression strategy switching and the corresponding influence management), we sought to examine whether the advisers' functional connectivity (FC) supported the link between single-brain activations and dual-brain synchronization and underpinned this two-in-one process. We first examined the link between the advisers' single-brain activations and dual-brain INS. Then, we examined the role of the advisers' FC in influencing the correlation between the advisers' single-brain activations and INS on the individual and group levels and tested whether strategy switching was reflected by the advisers' FC. Finally, we examined whether advisers' FC reflected advisers' strategy switching with individual differences by conducting correlation analysis and mediation analysis.

Pre-processing approach. Data were preprocessed using the Homer2 package in MATLAB 2020b (Mathworks Inc., Natick, MA, USA). First, motion artifacts were detected and corrected using a discrete wavelet transformation filter procedure. After that, the raw intensity data were converted to optical density (OD) changes. Then, kurtosis-based wavelet filtering (Wav Kurt) was applied to remove motion artifacts with a kurtosis threshold of 3.3 (Chiarelli et al., 2015). Based on a prior multi-brain study of social interactions (Cheng et al., 2022), the output was bandpass filtered using a Butterworth filter with order 5 and cut-offs at 0.01 and 0.5 Hz to remove longitudinal signal drift and instrument noise. Finally, OD data were converted to HbO concentrations.

Single-brain approach. Data were analyzed using SPM-based software (Ye et al., 2009). We extracted the HbO of the advisers (thirty-one advisers), focusing on the time series from the time the advisers saw the evidence to the time the advisers gave their confidence expression advice. The onsets and durations of the time series for each block of each trial were extracted to generate the stimulus design, which was then convolved with a typical hemodynamic response function using NIRS-SPM. The general linear model (GLM) then fitted these predicted signals to the data, yielding beta estimates (regression coefficients) for each parameter in the single-subject design matrices. The results of second-level, random-effects analyses via summary statistics (Friston et al., 2007) based on these estimates and effects were rendered on a standard MNI brain template.

First, we hypothesized that the overlapping regions involved in the 'defensive' strategy and the 'competitive' strategy were responsible for the adviser's strategy switching. So, we conducted one-sample t-tests for all channels to extract the brain activation of each adviser when applying the 'defensive' and the 'competitive' strategies that corresponded to incentive (or not) conditions. And the *p*-values of all channels were thresholded by controlling for the false discovery rate (FDR) (threshold at $p < 0.05$; Benjamini and Hochberg, 1995). We then validated the specific role of each channel involved in strategy switching with individual differences by conducting a Pearson correlation analysis between the $\Delta\beta_{\text{selection}}$ and the difference in brain activation (Δbrain activation) across Incentivized and Non-Incentivized conditions. Specifically, Δbrain activation = brain activation in the Incentivized condition – brain activation in the Non-Incentivized condition.

Finally, we used the PROCESS model 6 to construct a sequential mediation model with 5000 bootstrap resamples (Preacher, and Hayes, 2008) to test our investigation that the relationship between incentive contexts and strategic advice was mediated by self-reported perceived stress, and the adviser's brain activation.

Dual-brain approach. After pre-processing, wavelet transform coherence (WTC) was used to assess the cross-correlation between two time series for each channel of the thirty-one adviser-advisee dyad (Eq. (2)). Time series included the time the advisees saw the advice to the time the advisees decided to accept advice or not. The WTC of signals *i*(t) and *j*(t) is defined as:

$$WTC(t,s) = \frac{\left|\langle s^{-1} w^{ij}(t,s)\rangle\right|^2}{\left|\langle s^{-1} w^{i}(t,s)\rangle\right|^2 \left|\langle s^{-1} w^{j}(t,s)\rangle\right|^{2'}} \tag{2}$$

Here, *t* denotes the time, *s* indicates the wavelet scale, $\langle\cdot\rangle$ represents a smoothing operation in time, and *W* is the continuous wavelet transform (Grinsted et al., 2004).

First, we hypothesized that the process of influence management induced by the adviser's strategy switching was reflected in the changed INS. To identify the brain regions involved in influence management (accepting and rejecting advice), we calculated time-averaged INS and used a series of one-sample *t*-tests to assess INS in trials of accepting and rejecting advice separately (FDR corrected). Ultimately, channels showing significant INS were regarded as regions of interest and included in subsequent analyses. Consistent with single-brain activation analysis, we further explored the relationships between behavioral indicators and neural synchronization. The INS of the rejected trials was regarded as the baseline, and we computed the difference in INS (ΔINS) across accepted trials and baseline using the equation "ΔINS = INS of accepted trials – INS of rejected trials". We conducted a Pearson correlation between the average acceptance rate and ΔINS. Then, we conducted nonparametric permutation tests to examine whether the coupling only emerged in 'real' dyads that are interacting. We first reshuffled the data of all participants by pseudo-randomization to produce 1000 pseudo-dyads (e.g., time series from adviser No. 1 are paired with those from advisee No. 2). Second, we calculated the INS of 1000 pseudo-dyads. Finally, we compared the mean value of ΔINS of the real dyads with the null distribution of pseudo-dyads.

Next, we sought to examine whether INS reflected individual differences in the process of influence management induced by strategy switching. We first conducted the correlation between ΔINS and $\Delta\beta_{\text{selection}}$. We then used PROCESS model 4 with 5000 bootstraps resamples to examine whether the effect of INS on the acceptance rate was mediated by advisers' strategy switching (Preacher, and Hayes, 2008).

The link between single-brain activation and dual-brain INS. Neuroimaging work has identified that fNIRS functional connectivity (FC) showed great promise for providing insights into brain functional integration (Lu et al., 2010; Montero-Hernandez et al., 2019; Yang et al., 2020). Based on these studies, an exploratory analysis was conducted. We hypothesized that advisers' FC may support the link between advisers' single-brain activations and dual-brain synchronization and underpin the two-in-one process (i.e., the adviser's confidence expression strategy switching and influence management). To test this hypothesis, we first calculated trial-by-trial correlations between advisers' single-brain activations and INS.

We then calculated Pearson correlations between the adviser's HbO in the region involved in strategy switching and the HbO in the TPJ as indicators of functional connectivity (Lu et al., 2010). The right TPJ was selected as a region of interest based on earlier work related to (social) decision-making (Hertz et al., 2017). Second, we conducted paired-sample *t*-tests for FC during the task stage (including the time series from the time the advisers saw the evidence to the time the advisers gave their confidence expression advice) and rest. Third, we tested whether the correlation between the advisers' brain activation and INS of adviser-advisee dyads predicted the FC. Finally, we used the correlation analysis and mediation analysis to test whether advisers' FC reflected advisers' strategy switching with individual differences.

3. Results

3.1. Perceived stress mediated the effect of the adviser's incentive-induced confidence expression strategy switching during influence management

First, we sought to test how an adviser switched confidence expression strategies in the manipulation of incentive contexts to manage social influence, and whether and why there were individual differences in this process. In the current study, the $\beta_{\text{selection}}$ coefficient was estimated by conducting mixed effects regressions (Hertz et al., 2017). Positive values of $\beta_{\text{selection}}$ indicated that the participant followed the 'defensive' strategy, and negative values for this parameter corresponded to the 'competitive' strategy. Our results showed that, in general, the advisers applied 'defensive' strategies when they were incentivized (average $\beta_{\text{selection}}=0.09 > 0$, $t = 2.13$, $p = 0.041$) and 'competitive' strategies when they were not incentivized (average $\beta_{\text{selection}}=-0.08 < 0$, $t = -1.74$, $p = 0.091$), and demonstrated significant differences in $\beta_{\text{selection}}$ across incentive contexts (t=2.12, $p = 0.042$). Moreover, we observed the individual differences in strategy switching across incentive contexts (Fig. 3A). Specifically, some advisers applied the 'defensive' strategies in the Incentivized condition and 'competitive' strategies in the Non-Incentivized condition, while advisers applied the 'competitive' strategies in the Incentivized condition and 'defensive' strategies in the Non-Incentivized condition. We found that higher $\Delta\beta_{\text{selection}}$ was associated with an increased acceptance rate (r=0.41, $p = 0.022$; Fig. 3B), indicating that strategy switching was related to managing social influence.

Next, we conducted the regression analysis and serial mediation models to investigate the mediating effect of perceived stress in the incentive-induced strategy switching to manage the influence process. We first conducted the regression analysis, with incentive contexts, self-reported perceived stress, and their interaction effect as the independent variables, and $\beta_{selection}$ as the dependent variable. The results revealed a significant interaction effect between self-reported stress and incentive contexts ($\beta = 0.45$, $SE = 0.01$, $t = 5.03$, $p < 0.001$). $\beta_{\text{selection}}$ in the Incentivized context was significantly correlated with self-reported stress ($\beta = 0.58$, $SE = 0.01$, $t = 3.85$, $p < 0.001$), while $\beta_{\text{selection}}$ in the Non-Incentivized context was non-significant correlated with stress ($\beta = 0.02$, $SE = 0.02$, $t = 0.12$, $p = 0.902$) (Fig. 3C). These results suggested that incentive contexts modulated the effect of self-reported perceived stress on strategies. The mediation model then revealed a good-fitting model (CFI = 0.96, TLI = 0.98, RMSEA = 0.04), indicating that, our manipulations of incentive contexts caused reliable changes in self-reported perceived stress and related strategic advice, and ultimately managed social influence ($\beta_{\text{a1}} = 0.34$, $SE = 0.04$, $t = 3.41$, $p = 0.011$; $\beta_{\text{a3}} = 0.27$, $SE = 0.03$, $t = 2.83$, $p = 0.024$; $\beta_{\text{b2}} = 0.31$, $SE = 0.05$, $t = 3.00$, $p = 0.015$; Fig. 3D).

Additionally, to assess the stability of these results, we conducted a follow-up experiment with a larger sample of eighty-eight Chinese students as paired volunteers and replicated the above in this independent study (see supplementary materials).

Taken together, these results provided evidence that the incentive contexts modulated advisers' confidence expression strategies with large individual differences. While some advisers applied the 'defensive' strategy when incentivized and the 'competitive' strategy when not incentivized, other advisers applied the 'competitive' strategy when incentivized and the 'defensive' strategy when not incentivized. We identified that perceived stress played a key functional role in the process of incentive contexts modulated the advisers' strategies with individual differences. Moreover, we identify that strategy switching was crucial in managing social influence and reflected by the acceptance rate.

3.2. The single-brain mechanism underlying the process of the adviser's confidence expression strategy switching

After determining that the advisers exhibited incentive-induced confidence expression strategy switching, we sought to identify single-brain activations that supported this process. Results indicated that the 'defensive' strategy was associated with increased activation in the DLPFC (CH8, $t = 6.22$, $p = 0.006$, FDR corrected, and MNI: −23, 42, 50; CH11, $t = 4.22$, $p = 0.046$, FDR corrected, and MNI: 21, 55, 41), while the 'competitive' strategy was associated with increased activation in the orbitofrontal cortex (OFC, CH21, t=4.93, $p = 0.028$, FDR corrected, MNI: −13, 73, 12) (Figure S2). Moreover, we found that both the 'defensive' strategy (CH4; $t = 5.91$, $p = 0.011$, FDR corrected) and the 'competitive' strategy (CH4; $t = 4.48$, $p = 0.034$, FDR corrected) were associated with

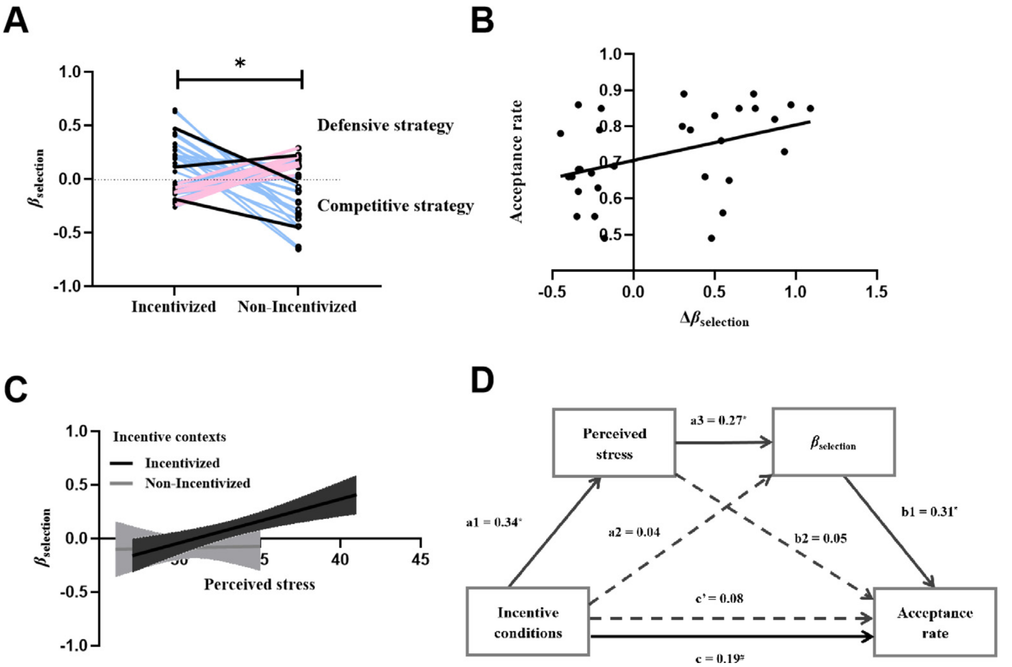

Fig. 3. The effect of incentives and self-reported perceived stress on individual differences in the process of the adviser's confidence expression strategy switching during influence management. (A) In general, the incentive context shaped confidence expression strategy switching. Moreover, there were individual differences in strategy switching across incentive contexts. Some advisers applied the 'defensive' strategies under Incentivized conditions and 'competitive' strategies under Non-Incentivized conditions (blue lines), while some advisers applied the 'competitive' strategies under Incentivized conditions and the 'defensive' strategies under Non-Incentivized conditions (pink lines), and the advisers did not switch strategies (black lines). (B) Higher $\Delta\beta_{\text{selection}}$ was associated with an increased acceptance rate. (C) The results suggested that incentive contexts modulated the effect of self-reported perceived stress on strategies. (D) A serial mediation model suggests that self-reported perceived stress and strategic advice mediated the relationship between incentive contexts and social influences. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, *ns* is non-significant. Error bars reflected 1 SEM.

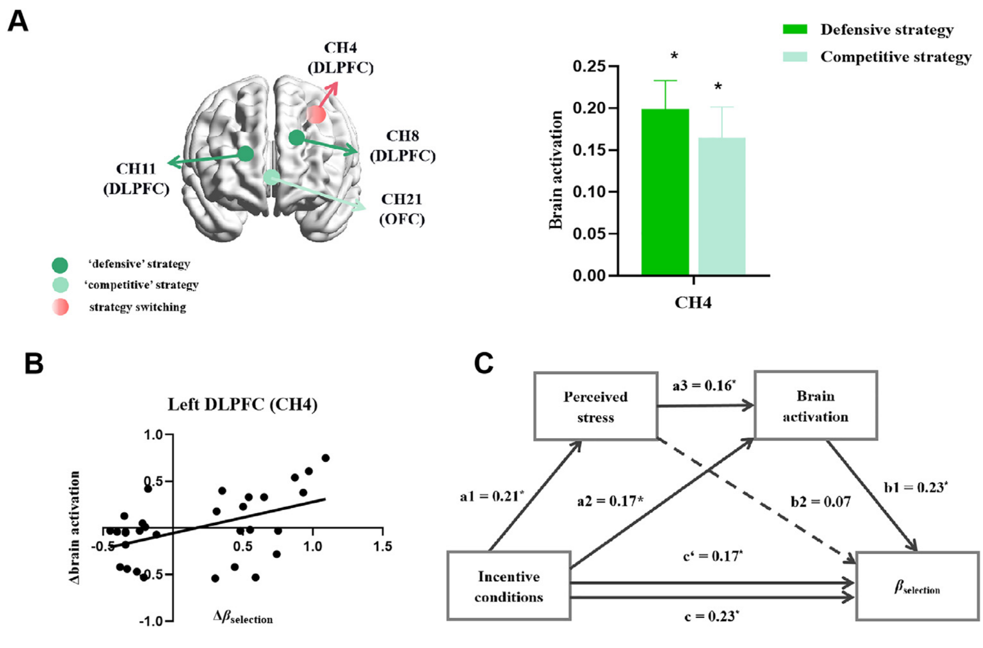

Fig. 4. The single-brain mechanism underlying the process of the adviser's confidence expression strategy switching. (A) Significant activations during switching confidence expression strategies were observed in the DLPFC and the OFC (*p*-value, FDR corrected). (B) Enhanced adviser's Δbrain activation was associated with higher $\Delta\beta_{\text{selection}}$. Specifically, Δbrain activation = brain activation in the Incentivized condition – brain activation in the Non-Incentivized condition. (C) A serial mediation model suggests that self-reported perceived stress and left DLPFC activation mediated the relationship between incentive contexts and strategic advice. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.01$, *ns* is non-significant. Error bars reflected 1 SEM.

increased activation in the left DLPFC (CH4, MNI: −38, 24, 55; Fig. 4A). Furthermore, Δbrain activation in the left DLPFC (CH4) was associated with $\Delta\beta_{\text{selection}}$ ($r = 0.47$, $p = 0.007$, Fig. 4B) across the Incentivized and Non-Incentivized conditions, demonstrating that a higher degree of strategy switching was associated with a greater change in brain activation. Based on all the above results, we considered the left DLPFC (CH4) as the marked neural substrate involved in the confidence expression strategy switching between the 'defensive' and the 'competitive' strategies with individual differences.

Finally, we sought to test whether both self-reported perceived stress and brain activation in the DLPFC had a mediating effect in the process of the adviser's incentive-induced strategy switching with individual differences. The mediation model revealed a good-fitting model, with results indicating that (CFI = 0.94, TLI = 0.95, RMSEA = 0.06), our manipulations of incentive contexts caused variations of self-reported perceived stress and relevant DLPFC brain activation, and ultimately reliable changes in giving strategic advice ($\beta_{a1} = 0.21$, $SE = 0.07$, $t = 2.95$, $p = 0.015$; $\beta_{a3} = 0.16$, $SE = 0.13$, $t = 1.94$, $p = 0.035$; $\beta_{b1} = 0.23$, $SE = 0.09$, $t = 3.16$, $p = 0.011$; Fig. 4C).

Taken together, these results provided evidence that the adviser's brain activation in the DLPFC supported the process of confidence expression strategy switching with individual differences and validated the key functional role of perceived stress in this process.

The dual-brain mechanism underlying the process of influence management induced by strategy switching

We sought to identify dual-brain INS that supported the process of influence management induced by strategy switching. By performing one-sample *t*-tests for INS of the accepted trials, we identified a significantly increased INS in the DLPFC (CH1, $t = 2.86$, $p = 0.025$, FDR corrected, MNI: 45, 24, 52) (Figure S2), the right TPJ (CH13, $t = 2.21$, $p = 0.048$, FDR corrected, MNI: 55, −67, 41) (Fig. 5A) and temporal lobe (CH23, $t = 3.45$, $p = 0.019$, FDR corrected, MNI: 52, −80, −5) (Figure S2). Concordant analyses of the rejected trials did not yield significant INS changes, so we regarded INS in the rejected trials as the baseline and ΔINS (INS in the acceptance trials minus INS in the rejected trials) as a dual-brain INS indicator. If INS indeed reflected mentalizing and influence management induced by strategy switching, then we expected to observe a correlation between ΔINS and the acceptance rate. Results showed that the greater ΔINS in the right TPJ (CH13) was associated with the higher average acceptance rate ($r = 0.46$, $p = 0.010$, Fig. 5B). No significant correlation was found in CH1 ($r = 0.28$, $p = 0.079$) and CH23 ($r = 0.22$, $p = 0.108$). A permutation test confirmed that the observed interactive effects on ΔINS in real adviser-advisee dyads are outside the 95% CI of a null distribution comprising 1000 pseudo adviser-advisee dyads (Figure S2). Therefore, the coupling was only found in 'real' dyads that were interacting.

Next, we sought to examine whether individual differences in strategy switching were reflected by INS. Correlation results showed that enhanced ΔINS in the right TPJ (CH13) was correlated with higher $\Delta\beta_{\text{selection}}$ during advice-giving interaction ($r=0.53$, $p = 0.002$, Fig. 5C). Then, we developed a mediation model and the results revealed a good-fitting mediation model (CFI = 0.98, TLI = 0.97, RMSEA = 0.04; Fig. 5D), indicating ΔINS caused strategy switching (i.e., $\beta_{\text{selection}}$), and ultimately managed social influence ($\beta_{a} = 0.38$, $SE = 0.01$, $t = 2.90$, $p = 0.020$; $\beta_{b} = 0.35$, $SE = 0.04$, $t = 2.08$, $p = 0.027$; $\beta_{c} = 0.38$, $SE = 0.02$, $t = 2.87$, $p = 0.020$).

Taken together, these results provided evidence that dual-brain INS in the right TPJ supported the process of influence management which was induced by strategy switching.

3.3. The adviser's DLPFC-TPJ functional connectivity regulated the link between the adviser's single-brain activation and dual-brain INS of the adviser-advisee dyad

Based on the previous results, we hypothesized that the adviser's incentive-induced strategy switching during influence management can be unfolded as a two-in-one process (i.e., the adviser's confidence expression strategy switching and influence management), and the adviser's functional connectivity (FC) may regulate the link between the adviser's single-brain activation and dual-brain INS of adviser-advisee dyad. First, we extracted the adviser's brain activation in the CH4 and INS of the adviser-advisee dyad in the CH13 and then conducted the Pearson correlations between these two indices, indicating a significant correlation between the adviser's brain activation and INS ($r = 0.42$, $p = 0.018$). Given that the adviser's FC of DLPFC-TPJ (CH4-CH13) showed a significantly increased during the task compared to the rest ($t = 3.99$, $p < 0.001$, FDR corrected), we focused on the adviser's FC of CH4-CH13 in the following analyses. Our results suggest that at the group difference level, stronger functional connectivity was associated with a stronger association between single-brain activation and INS ($r = 0.44$, $p = 0.013$; Fig. 6A), while at the individual level, such positive association was only observed in the individual who applied the 'defen-

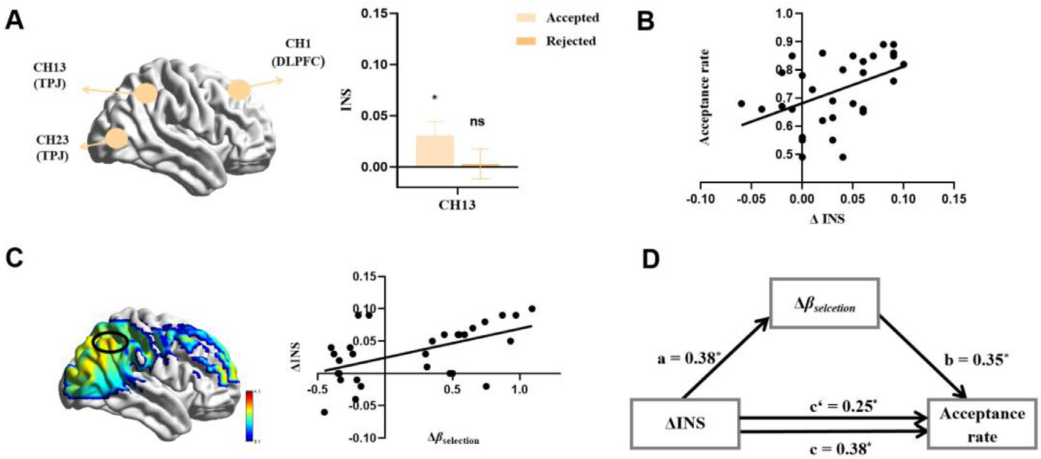

Fig. 5. The dual-brain mechanism underlying the process of influence management induced by strategy switching. (A) Significant INS were observed in the TPJ and the DLPFC. (B) Enhanced ΔINS in the right TPJ (CH13) was correlated with the higher acceptance rate. (C) Enhanced ΔINS was correlated with higher $\Delta\beta_{\text{selection}}$ during advice-giving interaction in the right TPJ (CH13). (D) A mediation model suggests strategy switching mediated the relationship between the ΔINS in the right TPJ (CH13) and social influence. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.01$, *ns* is non-significant. Error bars reflected 1 SEM.

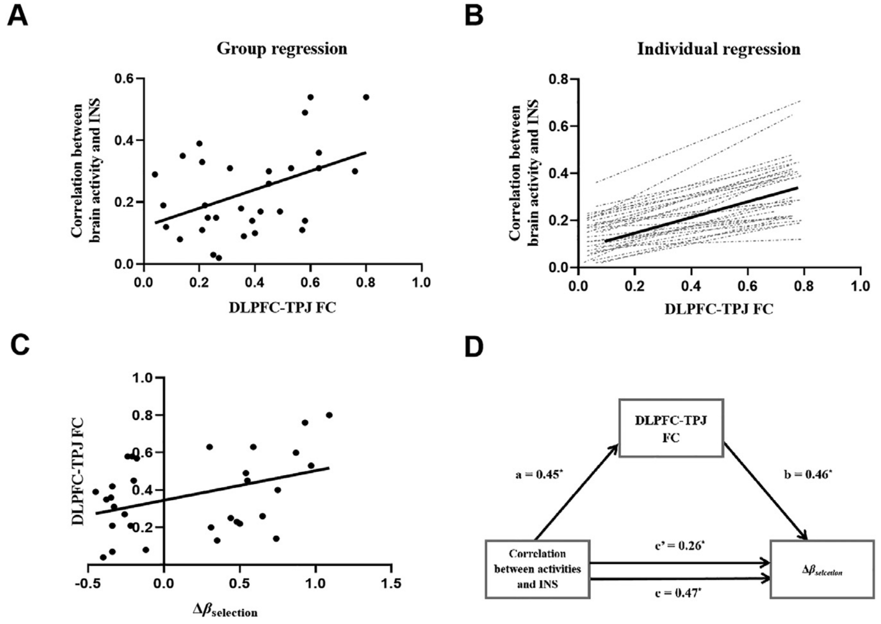

Fig. 6. The adviser's DLPFC-TPJ functional connectivity regulated the link between the adviser's single-brain activation and dual-brain INS of the adviser-advisee dyad. (A) The average correlation between the advisers' brain activation (CH4) and INS of adviser-advisee dyads (CH13) of an individual adviser predicts the average DLPFC-TPJ (CH4-CH13) FC of that adviser. (B) Within each adviser, variation in the correlation between the adviser's single-brain activation and INS of adviser-advisee dyad predicted variation in the adviser's DLPFC-TPJ FC. The correlation reported here was the correlation between single-brain activation and INS and the average FC from each trial. Each dotted line indicated the regression line of a single participant, Solid line indicated the group effect. (C) Stronger FC was correlated with higher $\Delta\beta_{\text{selection}}$. (D) A mediation model suggests that the advisers' DLPFC-TPJ FC mediated the relationship between the correlation between the adviser's single-brain activations and INS of adviser-advisee dyads and strategy switching. Error bars reflect 1 SEM.

sive' strategy in the Incentivized condition and the 'competitive' strategy in the Non-Incentivized condition ($t = 12.46$; Fig. 6B). Given these results, we expected that individual differences in strategy-switching were also reflected by the FC. Pearson correlation results showed stronger FC was correlated with higher $\Delta\beta_{\text{selection}}$ (r=0.39, $p = 0.032$; Fig. 6C). Mediation analysis (CFI = 0.96, TLI = 0.96, RMSEA = 0.04; Fig. 6D) suggested that, stronger FC resulted in an increased association between single-brain activations and dual-brain INS, and related to higher $\Delta\beta_{\text{selection}}$ ($\beta_{\text{a}} = 0.45$, $SE = 0.03$, $t = 1.76$, $p = 0.037$; $\beta_{\text{b}} = 0.46$, $SE = 0.03$, $t = 2.55$, $p = 0.021$; $\beta_{\text{c}} = 0.47$, $SE = 0.03$, $t = 2.84$, $p = 0.016$).

Taken together, our work offered advanced neural evidence revealing a link between the adviser's confidence expression strategy switching related adviser's single-brain activation in the DLPFC and the influence management related dual-brain INS of adviser-advisee dyad in the TPJ. During this two-in-one process, the adviser's DLPFC-TPJ FC regulated the link between the adviser's single-brain activation in the DLPFC and dual-brain INS of adviser-advisee dyad in the TPJ and higher DLPFC-TPJ FC supported the increased link between single-brain activations and dual-brain INS.

3.4. The descriptive model of the adviser's confidence expression strategy switching during influence management

There were two confidence expression strategies in advice-giving: the 'competitive' strategy and the 'defensive' strategy in the current study. When applying the 'competitive' strategy, the advisers report higher confidence when they are ignored by the advisees and report lower confidence when they are chosen by the advisees. When applying the 'defensive' strategy, the advisers report lower confidence when they are ignored by the advisee and report higher confidence when they are chosen by the advisees. Building on the above results, we developed a descriptive model of the adviser's confidence expression strategy switching during influence management (Fig. 7), proposing the psychological and neural mechanisms of the adviser's strategy switching between the 'competitive' strategy and the 'defensive' strategy to manage social influence. Specifically, incentive contexts can induce adviser's confidence expression strategy switching, with large individual differences (Fig. 7A). Compared to the context without incentive, some advisers may perceive more stress when being incentivized, and such stress shapes their strat-

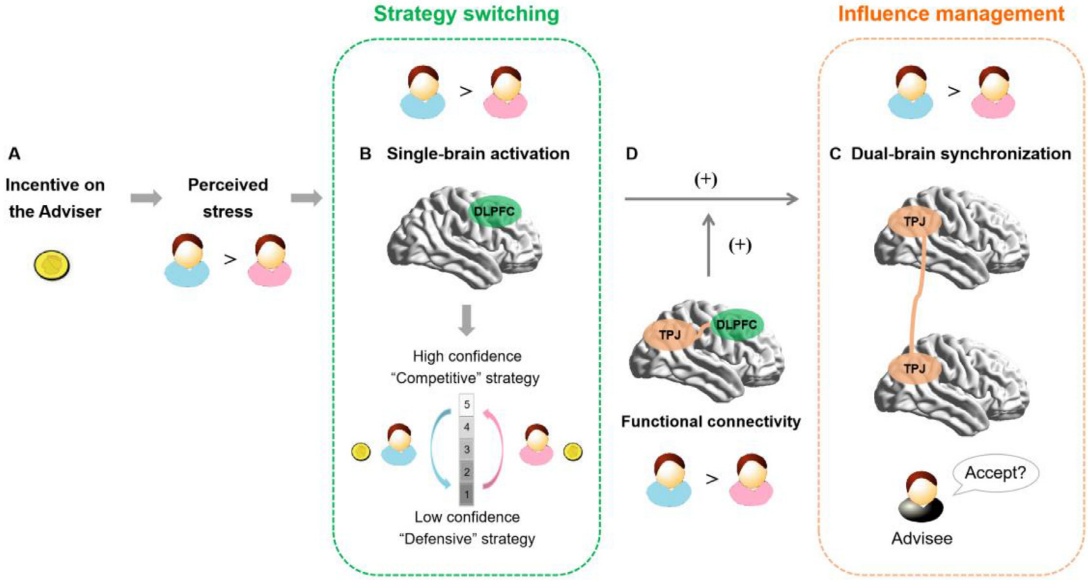

Fig. 7. The descriptive model of the adviser's confidence expression strategy switching during influence management. When applying the 'competitive' strategy, the advisers report higher confidence when they are ignored by the advisees and report lower confidence when they are chosen by the advisees. When applying the 'defensive' strategy, the advisers report lower confidence when they are ignored by the advisee and report higher confidence when they are chosen by the advisees. (A) Incentive contexts can induce the adviser's confidence expression strategy switching, with large individual differences. Compared to the context without incentive, some advisers may perceive more stress when being incentivized, and such stress shapes their strategy switching from the 'competitive' strategies to the 'defensive' strategies (indicated by the blue adviser). While other advisers may perceive relatively less stress when being incentivized and switch strategies from the 'defensive' strategies to the 'competitive' strategies (indicated by the pink adviser). Compared with the latter, the former approach of strategy switching achieves more advice-taking in the advisees (i.e., more effective influence management). Therefore, perceived stress is an essential psychological component mediating the individual incentive-induced confidence expression strategy switching and the corresponding influence management. (B) Activation in the left DLPFC in the adviser supports the process of confidence expression strategy switching. The adviser who switches strategies from the 'defensive' strategies when being incentivized to the 'competitive' strategies when being not incentivized is associated with higher DLPFC single-brain activation. (C) INS in the right TPJ between the adviser and advisee supports the process of influence management induced by strategy switching. The adviser who switches strategies from the 'defensive' strategies when being incentivized to the 'competitive' strategies when being not incentivized is associated with stronger TPJ dual-brain INS. (D) The functional connectivity between DLPFC and TPJ in the adviser's brain functions to link these two processes (i.e., the advisers' confidence expression strategy switching and influence management) by modulating the association between the adviser single-brain activation in DLPFC and dual-brain INS of the adviser-advisee dyad in TPJ. The higher FC further increases the association between single-brain activation in the DLPFC and dual-brain INS in the TPJ, ultimately enhancing strategy switching induced influence management.

egy switching from the 'competitive' strategies to the 'defensive' strategies. While the other advisers may perceive relatively less stress when being incentivized, and switch strategies from the 'defensive' strategies to the 'competitive' strategies (Fig. 7A). Compared with the latter, the former approach of strategy switching achieves more advice-taking in the advisees (i.e., more effective influence management). Therefore, perceived stress is an essential psychological component mediating the individual incentive-induced confidence expression strategy switching and the corresponding influence management (Fig. 7A). Neurally, activation in the left DLPFC in the adviser supports the process of confidence expression strategy switching (Fig. 7B) and the INS in the right TPJ between the adviser and advisee supports the process of influence management induced by strategy switching (Fig. 7C). The functional connectivity between DLPFC- and TPJ in the adviser's brain functions to link these two processes (i.e., the advisers' confidence expression strategy switching and influence management) by modulating the association between the adviser single-brain activation in DLPFC and dual-brain INS of the adviser-advisee dyad in TPJ (Fig. 7D).

4. Discussion

We set out to study how an adviser switched strategies to manage influence, and whether and why there existed individual differences during this process by conducting the present experiment. We identified that there were individual differences in the impact of incentive contexts on the advisers' confidence expression strategy switching and self-reported perceived stress mediated this process. We highlighted that the link between the adviser's single-brain activation in the DLPFC and dual-brain INS of the adviser-advisee dyad in the TPJ underpinned a two-in-one process (i.e., the adviser's confidence expression strategy switching and influence management), and such process was regulated by the adviser's DLPFC-TPJ FC. Given these results, we finally developed the descriptive model of the adviser's strategy switching during influence management.

Our findings converge with previous work which highlights that the advisers apply strategies to maximize their social influence (Hertz et al., 2017; Hertz et al., 2020; Hampton et al., 2008; Zaki et al., 2011). The majority of previous research on social influence has focused on exerting more influence on the targets—the "advisees" (Barton et al., 2014; Hamby et al., 2015; Izuma, 2013). However, far less is known about the cognitive and neurobiological processes at play in the persuaders—the "advisers". Here, we provide evidence for the advisers appear to apply the confidence expression strategies to improve their social influence. Moreover, scenarios in most previous studies are not interactive as the advisees' responses are set by the experimenter (Dean et al., 2015). One major strength of our study is that participants freely use strategic signals (such as confidence) to influence the advisees and flexibility to decide which strategy to apply. Our findings strengthen the ecological validity of the paradigm by generalizing previous findings to interactive human behavior. Previous studies suggested that metacognition, a process of individuals evaluating their own cognitive processes, is embodied in advising behaviors (Flavell, 1979; Bahrami et al., 2010;

Shea et al., 2014; Schnaubert et al., 2021). However, the process of the adviser's strategies applying, may not be a simple metacognitive judgment (Hertz et al., 2020). In this process, advisers first reassess their confidence in giving advice, which may involve metacognition, but importantly, advisers then flexibly express confidence in the advice to maximize social influence on others, which may involve more cognitive processes. Our findings suggested that advisers switched their confidence expression strategies depending on the contexts, which reflected both strategy choice and strategy switching. It is undeniable that metacognition is involved in strategy applying and strategy switching, but our descriptive model provides evidence that the cognitive processes of incentive induction and perceived stress may also be involved in advising behavior.

Behaviorally, our findings provide robust evidence that there are individual differences in the effect of incentive contexts on an adviser's strategy switching, and that self-reported perceived stress mediates this process. Previous research has shown that individuals do not consistently apply one rule to their decisions, but rather appear to make a strategic trade-off depending on specific contexts (FeldmanHall, Otto, and Phelps, 2018; Hill et al., 2017; Tenney et al., 2007; Van Baar et al., 2019). For example, FeldmanHall et.al (2018) argue that people are like chameleons in that they significantly enhance punishment strategies in the context of highly punitive measures. Furthermore, previous work has demonstrated that the incentive contexts would inevitably bring stress (i.e., reward and punishment, social norms, group setting) to the individuals in the context (Bhui et al., 2016; Dean et al., 2015; Nook et al., 2016) and ultimately induce the strategy switching in strategic interactions (Baumert and Emmrich, 2001; King-Casas et al., 2005; Lefebvre, and Stenger, 2020; Mobbs et al., 2009). Consistent with these findings, we observed individual differences in strategy switching.

Our mechanistic study opens a new avenue that the adviser's DLPFC-TPJ connectivity regulates the link between the adviser's single-brain activation and dual-brain synchronization of the adviser-advisee dyad. First, extending previous neuroimaging approaches, we jointly use single-brain and dual-brain approaches to reveal the neurocognitive mechanism of the adviser's strategy switching. The single-brain mechanism underlies that brain activation in the DLPFC supports the adviser's strategy switching. The DLPFC is involved in strategic deliberation and controlled decision-making (Fecteau et al., 2007; Gläscher et al., 2012; Yang et al., 2020; Zhang, and Gläscher, 2020). The dual-brain mechanism underlies that INS of the adviser-advisee dyad in the TPJ supports the process of influence management induced by strategy switching. The TPJ is involved in mentalizing and updating beliefs about others (Chen et al., 2020; Cheng et al., 2022; Liu et al., 2019; Nastase et al., 2019). To systematically uncover the dyad interaction, it is important to reveal the relationship between single-brain activation and dual-brain INS these two measurements. Second, extending previous studies which focus on single-brain activation and dual-brain INS findings independently, we offer advanced evidence that uncovers the link between single-brain activations and dual-brain INS underpinning the two-in-one process (i.e., the adviser's confidence expression strategy switching and influence management). However, our work was unable to provide direct evidence for the reason why the adviser's FC regulates dual-brain synchronization of the adviser-advisee dyad. We conjecture that DLPFC-TPJ connectivity may reflect 'social alignment' between the execution system (i.e., strategy switching) and observation system (i.e., influence management) in the human brain (Adhikari et al., 2013; Schenk and Colloca, 2020; Yang et al., 2020), thus regulating dual-brain INS. Future work could further explore how FC modulates dual-brain INS during strategy switching.

The second way in which our study opens a new avenue in the development of a descriptive model of the adviser's confidence expression strategy switching during influence management. A normative model of advice-giving demonstrates that the advisers will apply strategies to update their reporting confidence in their advice, rather than reporting their honest predictive confidence (Ban et al., 2017; Bayarri and Degroot, 1989). Moreover, Hertz and his colleagues (2017) develop a neural computational model for strategic advice-giving. In a competitive advice-giving task, they proposed that strategic advice-giving may rely on the management of influence and the comparison with their advice relative to the rival advisers. By developing a descriptive model, our work emphasizes how the advisers switch confidence expression strategies during influence management, which in turn motivates how willing the advisees are to accept or reject the advice. Our model provides a demonstration of a two-in-one process of the adviser's strategy switching (i.e., the adviser's confidence expression strategy switching and influence management) which is supported by the link between the adviser's single-brain activation and dual-brain INS between adviser and advisee. Extending previous theoretical models, our descriptive model highlights the interaction between the adviser and the advisee and reveals the psychological and neural mechanisms underlying the adviser's confidence expression strategy switching during influence management.

Some limitations of the current work suggest future research opportunities. First, we innovatively unveiled the mechanism of the adviser's strategy switching across contexts. However, it is possible that individual differences in personality traits may also influence adviser's strategies. For example, the advisers' context sensitivity has been shown to influence assessing their strategic decisions (Bonus, 2016; Wong, and Versace, 2011). Moreover, Hertz et al. (2017) and Zaatr et al., (2022) found that self-reported FNE score (Fear of Negative Evaluation) correlated with the advisers' advising strategies. For example, the advisers were more likely to follow the 'defensive' strategy when their self-reported FNE scores were higher. Since the influences of personality traits are beyond the scope of the current study, future work may design tasks and measure these related variables to comprehensively explore the reasons for the emergence of individual differences in strategy switching. Second, in the current study, the amount of reward and punishment was set at the same level (i.e., 10 points) under the Incentivized condition. A classic finding is that people are in general more averse to losses than gains (e.g., Gächter et al., 2022; Morewedge, and Giblin, 2015; Novemsky, and Kahneman, 2005). For example, a high level of gain might be needed to compensate for a low level of loss when making risky decisions (Botvinik-Nezer et al., 2020). Moreover, people would feel more negative emotions with expanding amounts of losses (Botvinik-Nezer et al., 2020; Novemsky, and Kahneman, 2005). It is possible that the strategy switching and the corresponding individual difference depend not only on whether the advisers are incentivized, but also on the level of the incentives and the differences in the context of gain and loss. Future studies may design parametrically incentivized tasks to tackle these questions. Third, although our findings provide neurocognitive mechanisms for the adviser's confidence expression in advice-giving, it remains unclear from the perspective of the advisees. Our work indicates that the advisee prefers to accept the adviser's advice with the 'defensive' strategy in the Incentivized condition and the 'competitive' strategy in the Non-Incentivized condition. An interesting research question arising from our dual-brain findings is what are the neurocognitive mechanisms underlying the advice-taking in advisees during the interaction. It is possible that the advisee evaluates the adviser's state of mind from the current context and decides whether to accept the advice or not, which may be associated with the TPJ and the DLPFC. Future work can clarify how and why advisees decide to accept advice or not. Furthermore, considering only the activation changes in HbO signaling may not be sufficient to rule out false positives and/or false negatives (Hakim et al., 2022; Tachtsidis, and Scholkmann, 2016). It has been noted that HbR seems to be more robust to systemic interference than HbO, but may be less sensitive to changes in regional cerebral blood flow (Hoshi, 2003) and have a lower signal-to-noise ratio (Mahmoudzadeh et al., 2013). Future work could therefore make interpretations of functional activation using both HbO and HbR, as well as record some physiological variables to account for systemic confounding/noise in the fNIRS signal, such as changes in heart rate (HR), blood pressure, respiratory rate, blood carbon dioxide concentration, and autonomic nervous system (ANS) activity.

In sum, the current study uncovered the single- and dual-brain mechanisms and developed a descriptive model regarding the adviser's confidence expression strategy switching during influence management. This work provides not only a general framework that integrates previous independent findings, but also a theoretical base for future investigations on strategic advice in various social contexts.

Data and code availability statement

Data and code of this project were obtained from the GitHub repository (available at https://github.com/xehui/Strategy-switching.git).

Data Availability

I have shared the link to my sample data and code at the Attach File step

Credit authorship contribution statement

Enhui Xie: Methodology, Conceptualization, Formal analysis, Writing – original draft. **Mengdie Liu:** Data curation, Conceptualization. **Keshuang Li:** Writing – review & editing. **Samuel A. Nastase:** Writing – review & editing. **Xiaoxue Gao:** Methodology, Writing – review & editing. **Xianchun Li:** Writing – review & editing.

Acknowledgments

This work is supported by the National Natural Science Foundation of China (32071082, 31900798, and 71942001), Key Specialist Projects of Shanghai Municipal Commission of Health and Family Planning (ZK2015B01), the Programs Foundation of Shanghai Municipal Commission of Health and Family Planning (201540114), the Research Project of Shanghai Science and Technology Commission (20dz2260300) and the Fundamental Research Funds for the Central Universities. Dr. Xiaoxue Gao is supported by Young Elite Scientists Sponsorship Program by China Association for Science and Technology (YESS20210176, 2021QNRC001).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.neuroimage.2023.119957.

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