

Choice reminder modulates choice-induced preference change in older adults

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Abstract

Objectives: Choices not only reflect preference but also shape preference. The choice-induced preference change (CIPC) occurs when making a decision modifies people's attitudes about the options. When people rate a series of items and then must choose between two items rated as equally attractive, they later rate the unchosen item as less attractive than before. One explanation is that the choice and the equal preference for two options cause a psychological discomfort known as cognitive dissonance, which can be reduced by changing the preference. The current study aims to investigate the age-related differences in the CIPC effect, and how explicit reminder of the previous choice modulates this effect.

Method: Using an artifact-controlled free-choice paradigm, with a sample of 79 younger and 76 older participants, we manipulated the choice reminder in two experiments.

Results: We found that compared with young adults, older adults are less susceptible to CIPC when their previous choices were not explicitly reminded. After boosting the salience of choice-preference incongruency by reminding participants of their previous choices, older adults showed comparable CIPC as young adults did.

Discussion: Our results suggest that older adults tend to downweigh the information that leads to cognitive dissonance and use this strategy only when such information is relatively implicit. The diminished CIPC in older adults could be one of the emotional regulation strategies that older adults engage in to maintain positive emotional states when making difficult decisions.

Keywords: cognitive dissonance, spreading of alternatives, choice reminder, free-choice paradigm, decision-making

Introduction

We constantly decide among alternatives across various domains of life. The act of choosing not only reveals our preference, but it may also actively shape our preference. When making choices, individuals' preferences can be modified or induced in this process (Brehm, 1956; Coppin et al., 2010). For example, after making a difficult choice between two equally preferred items, people tend to increase their preference for the chosen item and decrease their preference for the rejected item, known as the spreading of alternatives. The most influential explanation for this phenomenon is that the decision between two equally valued options causes a psychological discomfort known as cognitive dissonance, in which one holds two or more contradictory cognitions simultaneously, i.e., every desirable aspect of the rejected item and the undesirable aspect of the chosen item stands in contradiction to the choice that was made. Individuals are motivated to reduce this discomfort by altering their original preferences to match their choice. Hence, after making a choice, people tend to engage in dissonance reduction by evaluating the chosen item more favorably and evaluating the rejected item more negatively, known as the choice-induced preference change (CIPC) effect (Festinger, 1962; Luo & Yu, 2017).

Choice reminder and the age-related CIPC effect

The free-choice paradigm has been widely used to study the spreading of alternatives, whereby individuals are asked to (i) rate their preference for a set of items (e.g., art prints), (ii) choose between two of the items, and (iii) rerate the set of items presented in the first step (Brehm, 1956; Izuma et al., 2010). The CIPC effect has typically been measured as the increase in rating for the chosen item and the decrease in rating for the rejected item between the first and second reference ratings. In a typical free-choice paradigm, participants are informed whether they have chosen or rejected the item (e.g., "You chose this item") in the second rating session. This labeling could partially inflate the CIPC effect by highlighting both the preference and the choice behavior per se. A previous study found that the spreading of alternatives effect was significantly smaller for the "no reminder" group, compared to the "reminder" group, suggesting that the choice reminder modulates the CIPC effect (Salti et al., 2014). Another study showed that the spreading of alternatives effect was influenced by both the choice individuals actually made and the choice they believed they had made. (Luo & Yu, 2017), suggesting that preference can be modulated by explicit manipulation.

According to the Dynamic Integration Theory (DIT) proposed by Labouvie-Vief et al. (2010), due to the crystallized intelligence-related cognitive-emotional development in later life, older adults tend to have richer personal knowledge and better skills in regulating their inner dissonance. Specifically, with the increasing integration of automatic emotion systems with wisdom, older adults are able to not only tolerate but also work constructively with more diverse, complex, and dynamic stimulation (Worthy et al., 2011). This capacity may make older adults better at tolerating and reconciling contradictions and tensions (Grossmann et al., 2010; Labouvie-Vief et al., 2010). Previous research showed that as people age, they become better at adjusting their emotional regulation strategies in different contexts (Scheibe & Carstensen, 2010). Regarding the CIPC effect, as predicted by the DIT, older adults may become more practiced in managing multiple perspectives and the consequences of choice, and more skillful in dealing with internal conflicts (Baltes et al., 1992; Grossmann et al., 2012). As a consequence, they may be less likely to be influenced by cognitive dissonance, especially when the conflict is implicit. From this perspective, it is reasonable to hypothesize that older adults may pay less attention to cognitive dissonance and be better at coping with it, and thus, show a diminished CIPC effect, compared to young people.

Based on the selective attention theory (Johnston & Dark, 1986), when the information is apparent and catches their full attention, participants can no longer ignore it and need to directly deal with the resulting cognitive dissonance. We hypothesize that if the contradiction between choice and preference is explicit and salient, older adults may have difficulty neglecting the cognitive dissonance and show a comparable CIPC effect with younger adults. To test this hypothesis, we experimentally manipulate the saliency of participants' choices (no reminder vs. with reminder) in two experiments. The design allows us to investigate the potential underlying mechanism of the age-related CIPC effect by manipulating the salience of the dissonance source, which is the contradiction between choice and preference. We further hypothesized that in the "with reminder" condition, in which the contradiction between choice and preference is salient, it would take a longer time for participants to deal with the dissonance. Choice reminder may influence the CIPC effect through reaction time, and such mediation effect may be moderated by age. Memory also plays a role in displaying the CIPC effect (Salti et al., 2014). Due to the memory decline in older adults (Balota et al., 2000), it is likely that they do not remember which items have been chosen before, and thus show a reduced CIPC effect. In order to rule out this possibility, a memory test was included in the "no reminder" experiment (Exp. 1). The purpose of the memory test was to test

whether participants could remember which item they have chosen in the task rather than participants' general memory capacities. Thus, our memory test included the same pairs of items in the choosing session.

The artifact-controlled free-choice paradigm

According to Chen and Risen (2010) and Izuma and Murayama (2013), the classic free-choice paradigm could produce the observed behavioral patterns even without any change in preference because participants' choices during the choice phase already have additional information about their preferences. The artifacts of this typical Rate-Choose-Rate (RCR) paradigm are from the random noises of the two rating stages and the choice phase. In Chen and Risen (2010)'s study, they adopted a Rate-Rate-Choose (RRC) procedure as a control, in which the two rating sessions were performed after each other, followed by a choice between two options that were close in rank in the first rating. In this case, the choice in no way could have influenced the second rating, as the choice session comes after ratings. As suggested, we compared the spreading of alternatives between RRC and RCR conditions to estimate the spreading explained by the choice process *per se*.

Experiment 1 (no choice reminder)

Method

Participants

A power analysis was conducted using G*Power (Faul et al., 2014), with a medium effect size (f) of 0.25, alpha of 0.05, and a power level of 0.9. The power analysis showed that around 80 participants in total are needed. The final sample of Exp. 1 included 41 young participants (14 males; age $M = 21.00$ years, $SD = 2.45$) and 40 older participants (12 males; age $M = 66.08$ years, $SD = 3.21$; year of education $M = 13.98$, $SD = 5.51$, Table 1).

The Mini-Mental States Examination (MMSE) scores showed that all older participants met the criteria for normal cognitive function (ranging from 25 to 30, $M = 28.75$, $SD = 1.53$, Table 1) (Feng et al., 2012). All participants provided informed consent and participated in the study session based on a protocol that was approved by the Research Committee of the university. The whole experiment session lasted for an hour and all participants were reimbursed HK\$80 for time compensation.

Experimental task and Procedures

A set of 160 colored digital photos of food items on a white background were used as stimuli (Blechert et al., 2014). Participants were first asked to rate their degree of hunger at that moment on a 9-point scale (1 = not hungry at all, 9 = very hungry). Following the hunger rating, participants were required to perform four main experimental sessions, i.e., a) the first rating, b) first choosing, c) second rating and d) second choosing sessions, which consist of two conditions [i.e., the Rate-Choose-Rate (RCR) and Rate-Rate-Choose (RRC) conditions]. At the end of Exp. 1, an unexpected memory test was conducted to assess the participant's memory in the choosing sessions.

a) First rating session. Participants indicated their preferences for all the 160 food items. In each trial, one food item was presented on the screen for 2 seconds. Then participants indicated their preference for the food item on a scale from 1 (do not like at all) to 9 (like very much). The selected number was highlighted with a yellow box. The order of food items was randomly presented to participants.

b) First choosing session. Half of the food items, i.e., 80 items (40 pairs), were randomly selected and used in this session. Unknown to the participants, the food items presented in each trial were two items that have the same or similar ratings of ± 1 matched (Luo & Yu, 2017; Sharot et al., 2012). Participants were required to choose one food item that they prefer the most by pressing the corresponding number without a time limit. Then the selected food item was highlighted with a yellow box. In each trial, the selected food item is identified as a "chosen" item, and the unselected one is the "unchosen" item.

c) Second rating session. Participants were asked to rerate their preference for all 160 food items again without receiving information about their previous choices.

d) Second choosing session. Participants took part in the second choosing session with the remaining 80 food items that were not used in the first choosing session.

Memory test. In the unexpected memory session, 20 pairs of food items from the first choosing session and second choosing session were selected respectively. For each trial, participants were required to indicate which item of two was chosen by themselves in the previous sessions without any time limit.

Finally, participants again rated how hungry they felt at the end of the experiment. In this experiment, 80 food items were used in the Rate-Choose-Rate (RCR) condition and the other 80 food items were used in the Rate-Rate-Choose (RRC) condition (Figure 1). The preference changes between the RCR and RRC conditions can be regarded as the artifact-controlled CIPC effect.

Data Analyses

The analysis was conducted using the method described in previous studies (Luo & Yu, 2017; Sharot et al., 2009). Trials with a reaction time that less than 200 ms were removed from the analysis. We computed mean-corrected ratings for the first rating and second rating sessions. For each food item rated by each participant, a change of preference score was calculated by subtracting the mean-corrected first rating from the mean-corrected second rating. To quantify the degree of CIPC effect, a spreading of alternatives score was computed as the difference between the change in rating for the chosen item and the change in rating for the unchosen item between the first and second rating session. In order to control for the random changes (artifact) of the two rating sessions in the free-choice paradigm, we subtracted the scores in the RRC condition from the RCR condition to indicate the genuine CIPC effect. The moderated mediation analysis was conducted using model 7 by the Process macro (Hayes, 2013) in SPSS v.28. Bootstrapping analysis using 5000 resamples tested the hypothesized indirect effects.

Results of Exp. 1

The mean hunger ratings were significantly increased from the beginning of the experiment to the end of the experiment for both younger and older, $t_s > 3.75$, $p_s < 0.001$ (Table 1). There was no significant difference on the mean ratings in first rating session between young ($M = 5.37$, $SD = 1.07$) and older adults ($M = 5.28$, $SD = 1.08$), $t_{79} = 0.43$, $p = 0.67$. For the difference scores, the main effect of choice (chosen vs. unchosen) was significant, $F(1, 79) = 167.72$, $p < 0.001$, $\eta^2 = 0.68$. We also found a significant interaction effect of choice (chosen vs. unchosen) x condition (RCR vs. RRC), $F(1, 79) = 10.26$, $p = 0.002$, $\eta^2 = 0.12$. The post-hoc analysis found the spreading of alternatives effects in both RCR and RRC conditions ($p_s < 0.001$), confirming the existence of the artifact that choices hold information about true preferences. The spread is significantly larger in the RCR condition ($M = 0.77$, $SD = 0.46$) than in the RRC condition ($M = 0.57$, $SD = 0.61$), suggesting a genuine CIPC effect in the free-choice paradigm.

Importantly, the 3-way interaction effect of choice x age group x condition was significant, $F(1, 79) = 5.57, p = 0.02, \eta^2 = 0.07$. To decompose the 3-way interaction effect, for each participant, an artifact-controlled spreading of alternatives score was computed as [change in chosen_(RCR-RRC) - change in unchosen_(RCR-RRC)]. Post-hoc analysis showed a significant spreading of alternatives effect in young participants, $t_{40} = 3.62, p = 0.001$, but not in older participants, $t_{39} = 0.66, p = 0.51$. These results suggest that compared to younger adults, older adults demonstrated a diminished CIPC effect when their choices are not reminded during the second rating session (Figure 2A). The other effects were not significant, $ps > 0.24$.

We examined the memory performance (percentage of correct response), and found no significant difference between younger and older adults in both RCR (younger: $M = 0.90, SD = 0.09$; older: $M = 0.90, SD = 0.08$; $t_{79} = 0.27, p = 0.79$) and RRC condition (younger: $M = 0.95, SD = 0.07$; older: $M = 0.95, SD = 0.07$; $t_{79} = 0.49, p = 0.63$). These results suggest that the diminished CPIC effect in older adults cannot simply attribute to the memory of their choices. The ceiling effect on memory accuracy suggests that both groups have no apparent difficulty remembering their choices.

Experiment 2 (with choice reminder)

Method

Participants

A sample independent of Exp.1 was recruited. There were 38 young participants (12 males; age $M = 22.11$ years, $SD = 3.76$) and 36 older participants (9 males; age $M = 65.28$ years, $SD = 3.75$; year of education $M = 14.11, SD = 4.93$) in Exp. 2. The MMSE scores of older adults range from 24 to 30, $M = 28.44, SD = 1.78$ (Feng et al., 2012). All participants provided informed consent and were reimbursed HK\$80 for time compensation.

Experimental task and Procedures

The experimental task and procedures were identical to Exp. 1, except for the manipulation in the c) second rating session, in which a written reminder above the food item indicating the participant's choice during the first choosing session was presented ("chosen" or "unchosen"). No memory test was included in Exp. 2, as the choice was explicitly presented to participants.

Results of Exp. 2

Using the same data analysis method of Exp. 1, we found that the mean hunger ratings were significantly increased from the beginning of the experiment to the end of the experiment for both younger and older adults, $t_s > 3.79$, $p_s < 0.001$ (Table 1). There was no significant difference of the mean ratings in first rating session between young ($M = 5.35$, $SD = 1.19$) and older adults ($M = 5.26$, $SD = 1.13$), $t_{72} = 0.35$, $p = 0.73$. Consistent with the results of Exp. 1, we found a significant main effect of choice (chosen vs. unchosen), $F(1, 72) = 328.03$, $p < 0.001$, $\eta^2 = 0.82$, and a significant interaction effect of choice (chosen vs. unchosen) \times condition (RCR vs. RRC), $F(1, 72) = 27.50$, $p < 0.001$, $\eta^2 = 0.28$. These results also revealed a genuine CIPC effect in Exp. 2. Importantly, the 3-way interaction effect of choice \times age group \times condition was not significant, $F(1, 72) = 0.65$, $p = 0.42$, $\eta^2 = 0.009$. Post-hoc analysis showed a significant artifact-controlled CIPC effect in both young participants ($t_{37} = 3.27$, $p = 0.002$) and older participants ($t_{35} = 4.11$, $p < 0.001$). These results suggest that older adults demonstrated a comparable CIPC effect to younger adults when their choices are explicitly reminded during the second rating session (Figure 2B). The other effects were not significant, $p_s > 0.29$.

Results of Exp. 1 & Exp. 2

Manipulation check of choice reminder

To check the effectiveness of the explicit reminder manipulation, we conducted a 4-way repeated-measures ANOVA with the reaction time during the second rating session as the dependent variable, age group (older vs. young), and choice reminder (Exp. 1: no reminder vs. Exp. 2: with reminder) as the between-subjects factor, choice of the item (chosen vs. unchosen), and the condition (RCR vs. RRC) as the within-subjects factor. The results showed that the main effect of the age group was significant, $F(1, 151) = 25.72$, $p < 0.001$, $\eta^2 = 0.15$. Older participants ($M = 1628.50\text{ms}$, $SD = 735.99$) took longer time to make a choice than younger participants did ($M = 1028.60\text{ms}$, $SD = 736.47$). We also found significant interaction effects of condition \times reminder [$F(1, 151) = 4.18$, $p = 0.04$, $\eta^2 = 0.03$] and condition \times choice [$F(1, 151) = 5.14$, $p = 0.03$, $\eta^2 = 0.03$]. Importantly, the 3-way interaction effect of reminder \times age group \times condition was significant, $F(1, 151) = 4.17$, $p = 0.04$, $\eta^2 = 0.03$. Older adults in Exp. 1 took a significantly shorter time to rate the food items in the RCR

condition during the second rating session than the older participants in Exp. 2 did ($M = 1483.84$ ms vs. 1834.17 ms, $M_{diff} = -350.33$ ms, $SD = 178.48$, $p = 0.05$), suggesting that participants in the “no reminder” group may experience less cognitive conflict between preference and choice. No such difference was found in younger adults ($M = 1038.57$ ms vs. 1036.96 ms, $M_{diff} = 1.61$ ms, $SD = 174.93$, $p = 0.99$), suggesting that younger participants in the two groups may experience comparable cognitive conflicts. The other effects were not significant, $ps > 0.05$.

Please note that the ANOVA test of age group x choice reminder on the RT in the RCR condition during the first rating session revealed a significant main effect of age group, $F(1, 149) = 26.87$, $p < 0.001$, $\eta^2 = 0.15$, but the main effect of choice reminder and the interaction effect were not significant ($ps > 0.45$), suggesting that the longer RT effect we found in older adults was specific to the post-choice rating. These results indicate that older adults may experience an easier (shorter) time in rating the items when their previous choices for those items were not presented. It suggests that for older participants, “no reminder” during the second rating session may reduce their cognitive dissonance, and thus, they may need fewer efforts to reduce it, which leads to the shorter RT and smaller CIPC effect (Figure 3A).

Age group, choice reminder, and CIPC effect

We found a significant interaction effect of choice (chosen vs. unchosen) x reminder (no vs. with reminder), $F(1, 151) = 5.23$, $p = 0.02$, $\eta^2 = 0.03$, showing a significantly larger spread in the “with reminder” group, relative to the “no reminder” group, suggesting that the choice reminder manipulation modulates the CIPC effect.

The 4-way interaction effect of choice x age group x reminder x condition was significant, $F(1, 151) = 4.75$, $p = 0.03$, $\eta^2 = 0.03$. Post-hoc analysis of the artifact-controlled CIPC score showed no significant difference in the CIPC effect between “no reminder” and “with reminder” groups in younger adults ($M_{diff} = 0.04$, $p = 0.78$), while the difference in older adults was significant ($M_{diff} = -0.37$, $p = 0.006$). In addition, there was a significant difference between younger and older adults in the “no reminder” group ($M_{diff} = 0.29$, $p = 0.02$), but such difference was not significant in the “with reminder” group ($M_{diff} = -0.11$, $p = 0.41$). These results indicate that compared to younger adults, older adults demonstrated a diminished CIPC only when their choices are not reminded during the second rating session (Figure 3B).

Moderated mediation analysis

To better understand the mechanism of how choice reminder affects the CIPC effect, we conducted a moderated mediation analysis to examine whether the age group moderates the indirect effect of choice reminder on the CIPC effect in the RCR condition through reaction time (Figure 3C). To control for the general RT differences, we used the (mean $RT_{\text{second rating}} - \text{mean } RT_{\text{first rating}}$) as the mediator. Results showed that reminder manipulation was significantly associated with larger CIPC effect (path c'), $B = 0.17$, $SE = 0.08$, $t = 2.15$, $p = 0.04$. The interaction between choice reminder and age group on RT was marginal significant, $B = 47.35$, $SE = 24.44$, $t = 1.94$, $p = 0.05$. Choice reminder was significantly associated with a longer RT among older participants, but not among younger participants (path a). Furthermore, RT was positively associated with the CIPC effect (path b), $B = 0.0001$, $SE = 0.0001$, $t = 2.06$, $p = 0.04$. A boot-strapping analysis indicated that the indirect effect of choice reminder on CIPC through RT depends on age group. Specifically, the indirect effect is significant among older participants ($B = 0.06$, $SE = 0.04$, $CI: [0.002, 0.14]$), but not among younger participants ($B = 0.007$, $SE = 0.015$, $CI: [-0.02, 0.04]$). These results suggested that the association between choice reminder and the larger CIPC effect was partially explained by the longer RT (a proxy of greater cognitive dissonance). This mediation effect was moderated by age group. Our findings provided evidence that choice reminder modulates CIPC in older adults, and this can be partially explained by the different levels of cognitive dissonance they experienced during the decision-making process.

Discussion

In the present study with two experiments, we used an artifact-controlled free-choice paradigm involving both young and older adults to investigate age-related differences in the choice-induced preference change effect, as well as how this effect is modulated by the choice reminder. Our results demonstrated that older adults tend to show a reduced CIPC effect than young adults, only when no choice feedback was given during the second rating session. Results of reaction time during the second rating session, as well as the moderated mediation analysis, confirmed that older adults spend a significantly shorter time making responses when no feedback is provided, and it may indicate an easier time to re-rate the items and less cognitive dissonance experienced. We further showed that this diminished CIPC effect cannot be simply explained by the deficit of memory in older adults. After

reminding older adults of their previous choices, older adults showed comparable CIPC as young adults did, as when information about prior choices is apparent, cognitive dissonance becomes inevitable. The results of the current study suggest that compared with young people, older adults showed a diminished CIPC effect when their choices are not explicitly reminded, supporting the theory of cognitive dissonance.

Diminished CIPC effect in older adults

Several possible mechanisms can explain the diminished CIPC in older adults when the internal conflict is not salient. The changes in the CIPC effect in older adults may be linked to the goal and motivational shifts in older age. As predicted by the DIT, the more experienced emotional regulation skills in older adults, such as dealing with cognitive dissonance, may also contribute to the diminished CIPC effect. Therefore, older people may be less likely to engage in preference change to reduce the dissonance arising from inconsistent cognitions after making a choice. Moreover, older adults' experience of regret can also be one of the indications of their reduced sensitivity to dissonance effects. The concept of regret was introduced as a qualification of cognitive dissonance theory by Festinger and Walster (1964), whereby regret is a tendency towards a preference reversal among alternatives after making a choice and is postulated as the outcome of the person focusing on dissonant cognitions. When these dissonant cognitions are made salient, the amount of regret increases with the magnitude of dissonance (Festinger & Walster, 1964; Wicklund & Brehm, 2013). A review study on age factors related to regret suggests that due to motivational and cognitive shifts towards the positive, older adults may anticipate and experience relatively less regret, as well as be more skillful in regulating regret emotion (Västfjäll et al., 2011). Given that reduced dissonance is related to less regret emotion experienced, it may be another reason explaining why older adults show diminished CIPC.

Choice reminder modulates CIPC in older adults

In our study, the diminished CIPC effect in older adults was only observed when participants' choices were not explicitly reminded during the second rating session. Reaction time is a useful indicator of cognitive conflict processing (Snodgrass et al., 1967). The shorter response time in the second rating session for the participants in Exp. 1 (no reminder) compared to the ones in Exp. 2 (with reminder) also suggests that older adults may experience less cognitive dissonance when their choices are not reminded. By contrast, in Exp. 2 with the explicit choice reminder, the contradiction between choice and preference is

too salient to be ignored. In this case, both younger and older participants demonstrated comparable and significant CIPC effects, indicating that choice reminders enhance cognitive dissonance, and lead to an increased CIPC effect in both age groups. The moderated mediation results suggested that the RT indeed mediates the association between choice reminder and the CIPC effect, and age moderated this mediation effect. This finding further suggests that levels of cognitive dissonance contribute to the age-related changes in the CIPC effect.

Whether the CIPC takes place at the implicit or explicit levels of processing is still controversial. On the one hand, cognitive dissonance reduction can be a conscious strategy and it may require individuals to explicitly remember the choices they made. A recent study found that the CIPC effect only occurred when the choices were remembered (Salti et al., 2014). Another study further showed that the CIPC effect was associated with participants' meta-cognition, i.e., choice confidence and subjective certainty regarding the initial rating judgments (Lee & Daunizeau, 2020). Brain imaging research also demonstrated that the CIPC effect was observed only for choices that were remembered and were in turn correlated with the activity of the hippocampus, a key brain region that is associated with memory (Voigt et al., 2019). On the other hand, evidence shows that this preference change could rely on implicit processes. The CIPC has been demonstrated in infants (Silver et al., 2020), toddlers (Grosse Wiesmann et al., 2022), and capuchin monkeys (Egan et al., 2010). Moreover, amnesiacs showed choice-supportive re-evaluation of the alternatives despite that they had no explicit recollection of the initial choice (Lieberman et al., 2001), suggesting that CIPC may not need explicit memory. The results of the memory test in our current study also confirmed that the reduced CIPC effect in older adults in Exp. 1 (no reminder) is not correlated with their memory performance. Our results suggest that the cognitive dissonance reduction process could be at least partially unconscious, and the need to reduce such implicit internal conflict is less intense among older people. Explicit reminders may bring this relatively unconscious process to the conscious level and hence increase CIPC.

Comparison with previous research

Our results are consistent with the finding of Ito et al. (2019)'s study, which used a free-choice paradigm and found that the CIPC effect occurred in younger but not in older adults. Their neuroimaging data further showed increased activation in a conflict-related brain region - the dorsal anterior cingulate cortex (dACC) - during the choice task in younger participants,

but not in the older ones, suggesting that older adults may experience less cognitive dissonance due to the age-related decline of the dACC function. It is worth mentioning that no direct comparison of the genuine CIPC effect between younger and older adults was reported in this study, leaving it unclear whether the group difference was statistically significant. Our current study extended the previous research and provided evidence of the age-related difference in artifact-controlled CIPC effect using the free-choice paradigm. Moreover, we experimentally examined how the saliency of conflicts between choice and preference influences the age-related difference in the CIPC effect. Our results suggest that when the cognitive conflict is too apparent to be avoided, downweighing such information may not be a useful strategy to reduce dissonance. The findings could be extended to other cognitive dissonance-related behavioral phenomena, such as guilt- and regret-driven behavioral changes.

Limitations

A few caveats about the present study should be mentioned. Firstly, consistent with previous studies (Colosio et al., 2017; Izuma et al., 2010), only food items were used in the current study. It is unclear whether the findings can be extended to other choice domains that are more complex and have real consequences for participants, such as financial or health plans. Secondly, items in some choice trials were not perfectly equal due to practical constraints, which may lead to noise in initial preference. Thirdly, the relatively small effect size in the current study calls for replication studies. The conceptual and practical relevance of our findings should also be interpreted with caution. Fourthly, we did not directly measure cognitive dissonance but inferred from participants' choices and reaction times. Neuroimaging studies using event-related potential (ERP) or functional magnetic resonance imaging (fMRI) are needed to better understand the age-related changes in cognitive dissonance and how it influences choice behaviors.

Conclusion

In conclusion, the present study with two experiments has added value to the understanding of choice-induced preference change by revealing that the magnitude of preference change differs with age such that older people showed a less degree of post-decisional spread, especially when the cognitive dissonance reduction process is implicit. Our results suggest

that the diminished CIPC in older adults could be one of the strategies that older adults engage in to help regulate emotions, especially to maintain positive emotional states when making difficult decisions. This may also be related to the reduced negative emotional experience among older people after making decisions, such as disappointment and regret. By ignoring the potential dissonance, older adults may feel more satisfied with their past decisions. Therefore, the diminished CIPC could serve as a protective strategy to maintain emotional well-being and thus be a resilience factor in old age. Aware of such diminished CIPC effect may help policymakers design better choice structures for older adults (Hansen et al., 2016). Our findings may inform behavioral nudges, such as the dissonance-based interventions (DBI) that aim to promote healthy behaviors among older adults (Cooper & Feldman, 2020). An explicit reminder would be a helpful nudge to induce behavioral changes in older adults. Future research may take the saliency of information into account when studying emotions and behaviors in older adults.

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Table and figure captions

Table 1. Participants' demographic information in Exp. 1 and Exp. 2.

	Exp. 1: No reminder		Exp. 2: With reminder	
	Younger adults	Older adults	Younger adults	Older adults
Sample size	41	40	38	36
Age	21 (2.45)	66.08 (3.23)	22.11 (3.76)	65.28 (3.75)
No. of male	14	12	12	9
MMSE	--	29.00 (2.23)	--	28.51 (1.76)
Year of education	--	13.98 (5.51)	--	14.11 (4.93)
Hunger rating (begin)	4.10 (2.21)	3.28 (1.95)	3.42 (1.88)	2.44 (1.59)
Hunger rating (end)	5.61 (2.35)	4.38 (2.38)	4.82 (2.46)	3.28 (2.08)

Note. Means and standard deviations are in parentheses (if applicable). MMSE = Mini-Mental State Examination.

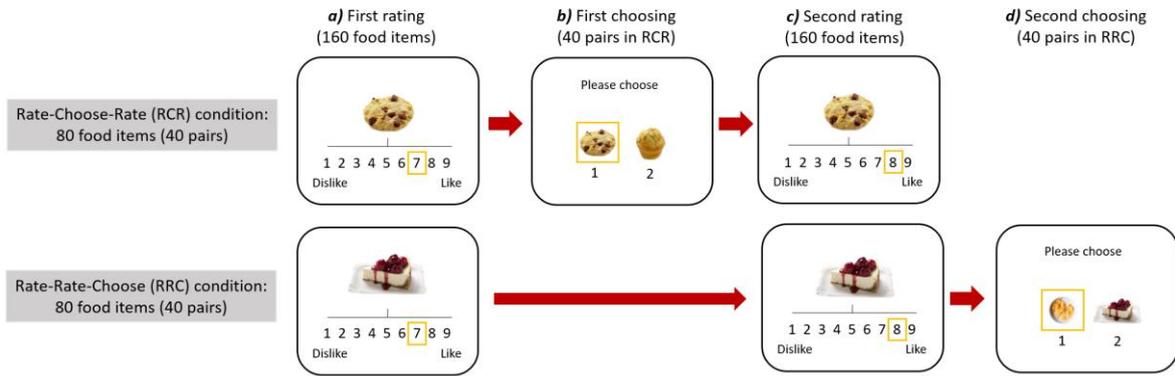
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Figure 1. Illustration of the experimental task. During each trial of the *a*) first rating session, participants were presented with a picture of a food item and were asked to rate their preference for the food item on a 9-point Likert scale. A yellow box highlighted the selected rating. All 160 food items were presented in random order. In the *b*) first choosing session, half of the food items (40 pairs in RCR condition) with the same or +/-1 difference in initial ratings were presented on the screen simultaneously, and participants were required to choose the food item that they prefer the most. The chosen item was highlighted with a yellow box. In the *c*) second rating session, participants re-rated all the food items again. In Exp. 1, no feedback on whether the item was chosen or unchosen was given, while such feedback was provided to the participants in Exp. 2. *d*) Another half of the items (40 pairs in RRC condition) were presented in the second rating session, the procedure is identical to the first choosing session.

Figure 2. Age difference and conditions on the CIPC effect. **A.** Choice-induced preference change for older and younger participants in Exp. 1 (no reminder) across RCR and RRC conditions. **B.** Choice-induced preference change for older and younger participants in Exp. 2 (with reminder) across RCR and RRC conditions. Error bars indicate ± 1 standard error of the mean. * $p < 0.05$.

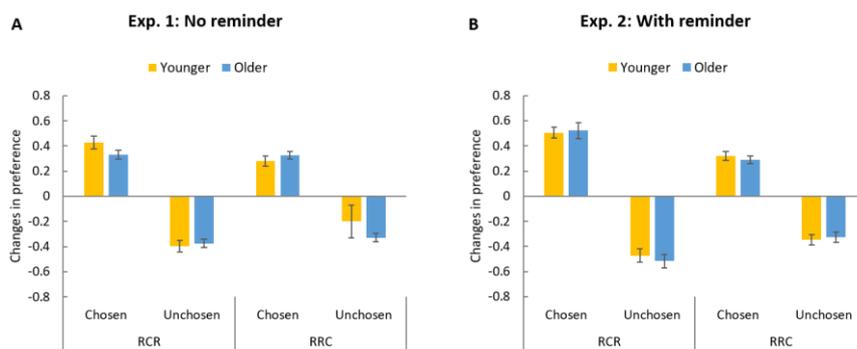
Figure 3. Age difference and the choice reminder on the CIPC effect. **A.** Older participants' reaction time is reduced in the RCR condition during the second rating session when their choices are not reminded. Error bars indicate ± 1 standard error of the mean. **B.** Compared to younger participants, older participants demonstrated a diminished choice-induced preference change effect when their choices are not reminded during the second rating session. **C.** Age group moderates the mediating effect of choice reminder on the CIPC effect in RCR condition through reaction time (the mean difference in reaction time between the second and first rating sessions). The numbers refer to unstandardized regression coefficients and their corresponding standard errors in parenthesis.

Figure 1



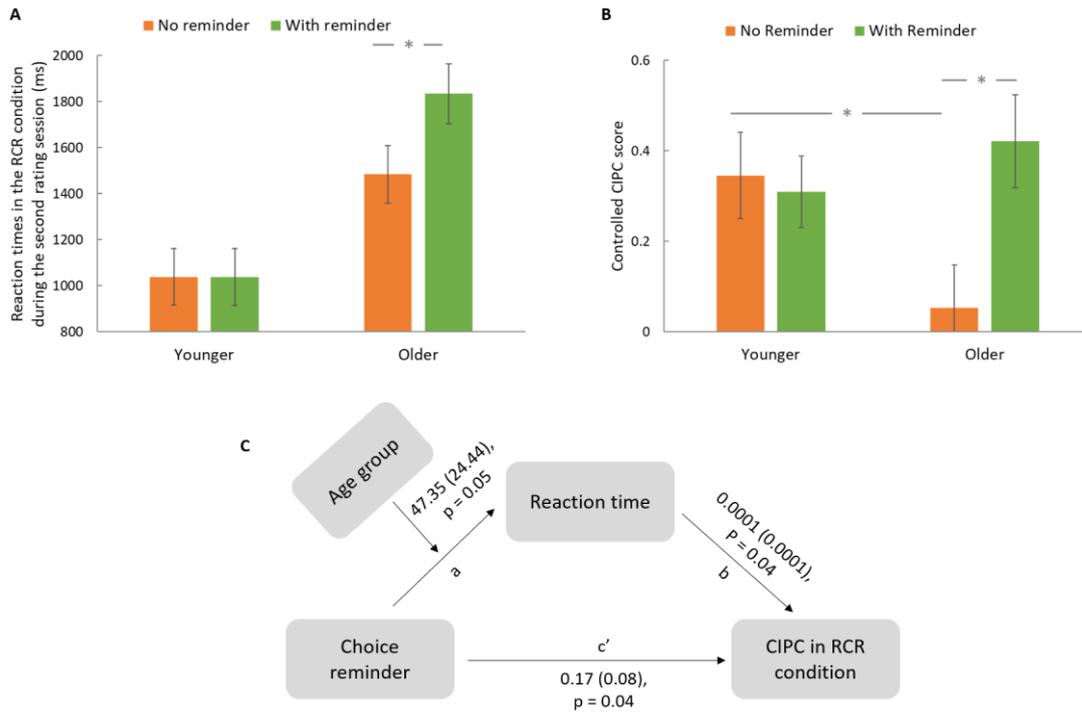
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Figure 2



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Figure 3



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