



Shaping Preferences Through Memory: Aged-Related Mechanisms in Dissonance Reduction

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Abstract

Preference change is a robust phenomenon observed in internally guided decision-making situations. Choice-induced preference change, in particular, occurs when individuals revise their preferences to align with their choices, reducing cognitive dissonance—a psychological state of discomfort arising from conflicting cognitions. Episodic memory has been suggested to play a role in this process, by helping recall choice-relevant information that reinforces post-choice preferences. However, age-related declines in memory may weaken this mechanism, leading to diminished preference adjustments in older adults. This study explored the relationship between episodic memory and choice-induced preference change in young and older adults. A sample of 33 healthy subjects aged 20-75 years underwent an adapted free-choice paradigm that included a recognition memory test for the choice made. Our results showed that younger participants exhibited significant preference changes in both overall and remembered choices, whereas older participants showed no such adjustments. These findings suggest that episodic memory supports choice-induced preference change in younger adults. In contrast, other mechanisms susceptible to aging may underlie dissonance reduction in older adults such as executive functions and/or emotional-affective factors.

Keywords: Choice-induced attitude change; cognitive dissonance; episodic memory; recognition memory; aging

Introduction

Cognitive dissonance was first defined by Leonard Festinger (1957) as a state of unpleasant emotional arousal that occurs when there is an inconsistency between cognitions, such as thoughts, attitudes, beliefs, and behaviors. One common way to reduce dissonance is through choice-induced preference change (CIPC). This typically occurs in the free choice paradigm, when, after choosing between two similarly pleasant stimuli, people tend to rate the selected items as more attractive and the rejected items as less attractive (Brehm, 1956). This tendency is called "spread" (or diffusion of alternatives). As some authors have pointed out the original paradigm contains a statistical artifact, where the predicted change in preference might occur even without a real change in the true preference (Chen & Risen, 2010; Izuma, K., Murayama, K., 2013). To address this methodological issue, a control condition (Rating-Rating-Choice/RRC) was added to the classic sequence (Rating-Choice-Rating/RCR). In this revised paradigm used nowadays, there are 4 phases: 1) in the Rating1 task, participants rate stimuli according to their preferences; 2) in the Choice1 task, they choose the object they prefer from pairs of items with similar ratings; 3) in the Rating2 task, subjects rate again the same items from Rating1 task; 4) in the Choice2 task (the control condition), they select preferred object from different pairs than those used in the Choice1 task (see Figure 1).

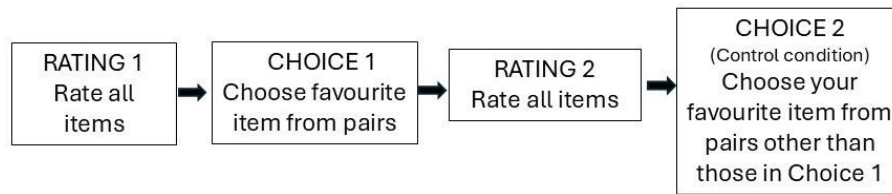


Figure1 Sequence of experimental phases in the revised free-choice paradigm

There is ongoing theoretical debate regarding the mechanisms underlying CIPC. Some models argue that it is an involuntary bottom-up process (Lieberman et al., 2001). In this context, Lieberman and colleagues (2001) examined the performance of amnesic patients (mean age 64.5 years, range 40-80 years) and healthy adults (mean age = 61.7 years, range 43-73 years) using the classic free-choice paradigm, which included a memory task requiring recognition of previously choices. Their findings documented that both groups exhibited similar choice-induced attitude changes, suggesting that explicit recall of counter-attitudinal behavior is not necessary to reduce post-choice dissonance. According to the authors, this suggests that changes in subjective preferences are driven by a low-level and automatic mechanism independent of episodic memory. However, this study did not address the statistical artifact identified by Chen and Risen (2010).

Other models propose that CIPC is regulated by high-level top-down mechanisms, involving episodic memory. In the study by Salti and colleagues (2014), the aim was to investigate CIPC using the revised free-choice paradigm in young people. Their experiment involved two groups of participants: the “with reminder” group, including subjects that were reminded of their Choice1 task decision, during the Rating2 (RCR sequence), and the “without reminder” group (RRC sequence). Preference change was induced by choice only in pairs for which the choice was remembered, highlighting the involvement of episodic memory in CIPC. The involvement of episodic memory in CIPC has been confirmed in subsequent neuroimaging studies (Chammat et al., 2017). Chammat and colleagues (2017) utilized the revised free-choice paradigm and in addition to the traditional sequence (Rating1 task, Choice1 task, Rating2 task, Choice2 task) included also a recognition memory test and a familiarity test. In the first experiment, fMRI was applied to healthy subjects (mean age=25.3 years, SD=3.7 years) throughout the entire task. Activation of the left hippocampus was observed during the Rating2 task, demonstrating a correlation between hippocampal activity and conscious episodic memory and CIPC. Moreover, this study compared the performance of amnesic patients with Mild Cognitive Impairment (aMCI) (mean age=69.3 years, SD=10 years) with the performance of matched control participants (mean age=73.25 years, SD=10.4 years). Behavioral data documented that amnesic patients forgot more items than controls and showed a change in preference only for remembered items, but not for forgotten ones. The authors suggested that episodic memory is necessary for preference change to occur.

The relationship between CIPC and episodic memory has also been investigated in relation to aging. An fMRI study by Ito and colleagues (2019) used the revised free choice paradigm to compare 14 young participants (mean age =20.33 years) and 14 healthy elderly participants (mean age 65.83 years). A paradigm similar to the one used in the study of Salti et al. (2014) was employed, including a reminder of the choice presented during the Rating2 task, for both groups. The behavioural data



showed that CIPC occurred only in young subjects. fMRI scans revealed increased activity in the right dorsal anterior cingulate cortex (dACC) in the young participants, suggesting an increase in cognitive conflict during decision making and highlighting the role of this area in internal inhibition when choosing between two alternatives. In contrast, elderly people exhibited less dACC activity during difficult choices. These findings suggest that the ability to reduce dissonance declines with age. The authors explained this phenomenon by attributing it to emotional changes associated with aging, including an increase in positive affect and a decrease in negative affect (Baltes et al., 1990; Carstensen, 2006; Heckhausen et al., 2010). Similar results were found in a recent study by Huang et al. (2023). The authors investigated whether an explicit reminder of previous choices could modulate the effect of age on dissonance reduction through attitude change. The same paradigm as Salti et al. (2014) was used, with two experiments (one with and one without a reminder), comparing young adults (mean age = 22.11 years) and elderly adults (mean age 65.28 years). Elderly adults showed a lower CIPC than younger adults, only when choices are not explicitly remembered (i.e. when there is no reminder). However, both elderly and younger subjects showed a significant dissonance reduction when the choice reminder was presented during the Rating2 task, suggesting that memory plays a role in CIPC. According to the authors, these findings indicate that elderly people tend to underestimate the information which leads to cognitive dissonance and use this strategy only when this information is relatively implicit. The result of these studies contrasts with those of Lieberman and colleagues (2001), who documented that both healthy elderly and elderly patients with amnesia exhibited typical CIPC.

The aim of the present preliminary study is to use the same paradigm as in the study by Chammat and colleagues (2017) to test the relationship between CIPC and episodic memory in the context of aging.

Understanding this relationship could clarify the influence of explicit processes in the choice-induced attitude change and determine whether the role of memory is age-related.

Experimental task

Methods

Participants

We recruited a sample of 33 healthy participants (15 males; 18 females), ranging in age from 20 to 76 years (mean age = 37,7 SD = 19,2; education mean = 16,03 SD= 2,21). All participants were right-handed (Edinburgh Handedness Inventory, mean QL: mean = 62,2 SD= 29,12) Italian native speakers who were naive to the purposes of the study. They had normal or corrected to normal vision and no previous history of neurological or psychiatric problems.

Participants were divided into two groups based on their age: a young group (age <50 years, N = 22; 10 males, 12 females) and an elderly group (age >50 years, N = 11; 5 males, 6 females). The elderly group underwent the Mini-Mental State Examinations (MMSE) (Folstein et al., 1975) which excluded deficits in general cognitive functions (averaged corrected scores for age and education = 28,29; cut-off = 24). The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all subjects.



Stimuli

A total of 120 images of representative travel destinations were used as stimuli. Each image included the name of the travel destination and the name of the country in brackets, written below each picture (font Aptos, size 30). The images were sourced through personal research, or were obtained from Wikimedia Commons, under the CC0 1.0 licence (<https://creativecommons.org/publicdomain/zero/1.0/>). All images were converted to BMP format and to ensure homogeneity in size, a range of 7.90-7.81 cm for height and 11.90-11.81 cm for width was used. Were presented to the right and left of the screen. Twenty images were used as distractors and were not included in Choice1 task and Choice2 task.

Procedure

The experimental task was based on the adapted free-choice paradigm, used in previous studies (Chammat M. et al., 2017). To control noisy factors, present during the rating process and to verify that any changes were indeed due to the choices made (Chen & Risen, 2010), we included a control condition, called Rating-rating-choice, compared to the experimental Rating-choice-Rating condition. Following Chammat et al. (2017) the experiment consisted of six tasks: a pre-choice task (Rating1); a first-choice task (Choice1); a post-choice task (Rating2); a second-choice task (Choice2), a recognition memory test (Memory Test) and a familiarity test (see Figure 2).

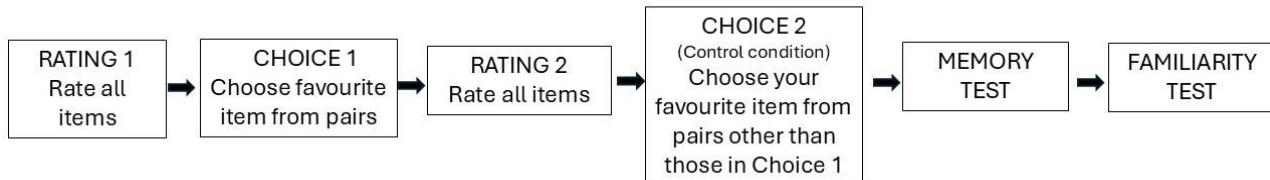


Figure 2. The adapted free-choice paradigm used in the previous study of Chammat et al. (2017).

In the Rating1 task, subjects rated all 120 images, one at a time, on a scale from 1 to 8, according to their desire to visit a specific destination (1= I absolutely do not want to go there; 8= I would very much like to go there). Each trial in the Rating1 task began with a fixation point lasting 3000ms, followed by an image of the destination displayed for 3000ms in the center of the screen, after which the fixation point would reappear until the subject responded. The inter-stimulus interval was 3000 ms. According to the individual rating scores, 50 pairs of images were made and divided into 2 equivalent sets of choice pairs. Each set included 25 images with equal or similar ratings (i.e. with a difference in scores ≤ 1). The set of choice pairs was different across individuals.

During the Choice1 task, a set of 25 choices was presented. Participants were asked to choose between two images of destinations previously rated in the Rating 1 task based on which one they would most like to visit. A fixation point was presented for 3000 ms, followed by the choices for 3000 ms, after which a fixation point reappeared while subjects made their choice.

The Rating2 task and the Choice2 tasks were identical to the Rating1 task and Choice1 task respectively except that the Choice2 task included a different set of 25 choice pairs.



In the Memory test, subjects were asked to recognize the choices made in the Choice1 and Choice2 tasks. All 120 images were presented one at a time in the center of the screen and for each image, participants were asked to select the option “Rejected” or “Chosen” to indicate if they remembered to have rejected or chosen that image, respectively. To prevent explicit memorization of the choices, subjects were not informed of this test at the beginning of the experiment. In the familiarity test, all 120 images were shown, and subjects rated how familiar they were with each location on a scale from 1 to 8 (1=“ I do not know this location at all”; 8=“ I know this location very well”).

Data analysis

First, we compared the performance in the memory test between the two groups of participants (young group vs. elderly group) in terms of accuracy, that is the percentage of correctly recognized choices in the recognition memory test.

To control for any effect due to the familiarity with the images of destinations, the familiarity scores for the images were averaged and compared between the two groups of participants.

For each condition RCR and RRC, the averaged spread was calculated as an index of the attitude change induced by the choice. For each pair of choices made, the spread was calculated using the following formula: Spread= (Rating2 of the chosen image - Rating1 of the chosen image) - (Rating2 of the rejected image - Rating1 of the rejected image). A higher spread value in RCR than in RRC condition indicates a choice-induced change in preference and a dissonance reduction.

We compared the averaged spread in the condition RRC and in the condition RRC within the two groups of participants (young group and elderly group) in overall choices made (All choices).

To test the effect of episodic memory on choice-induced attitude change, we compared the averaged spread in the condition RRC and in the condition RRC within the two groups of participants (young group and elderly group) in choices in which each of the two paired images was correctly remembered as chosen or rejected (Remembered choices) and in choices in which each of the two paired images was not correctly remembered as chosen or rejected (Not remembered choices).

The data was analysed using a two-tailed t-test; the level of significance was set at $p < .05$.

Results

Memory test

In the memory test, the mean percentage of choices remembered correctly (hits) for the young group and the elderly group respectively, were: 61% (SD= 6) and 55% (SD= 5). The two-sample Student's t-test showed that the elderly participants were significantly less accurate than the young participants when they had to remember their choices ($t(25) = 2.05$; $p = 0.005$) (Figure 3).

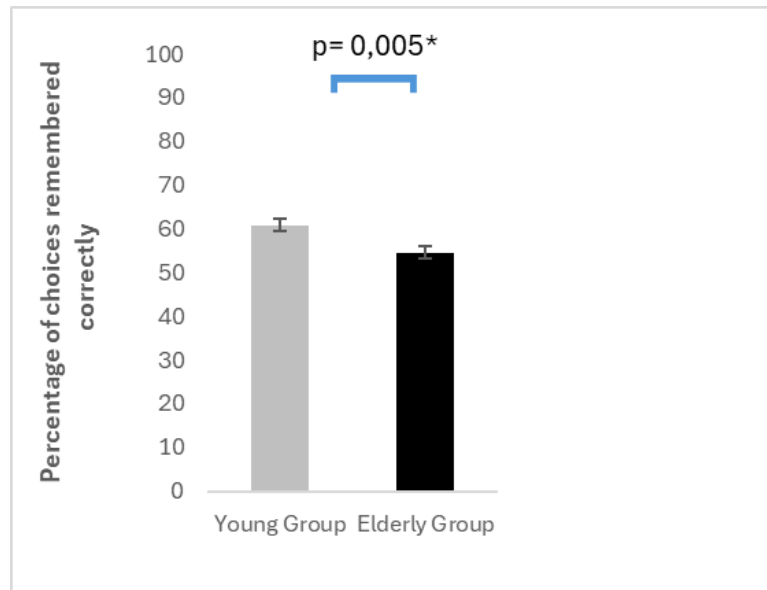


Figure 3. Mean percentage of remembered hits in the two groups. Error bars indicate the standard error of the mean.

Familiarity with the images

Young people had a mean familiarity score of 3.84 (SD= 1.98), while elderly people 4.11 (SD= 2,19). However, the comparison between the two groups was not significant ($t(18)=2,10$; $p= 0.47$), thus the familiarity with the images of destinations did not affect the difference in performance between the two groups.

Choice-induced attitude change

All Choices

The young group showed a significant choice-induced attitude change in all choices made (RCR=0.72, RRC=0.52; $t(21)=2.07$; $p=0.009$) while the elderly did not (RCR=0.41, RRC=0.58; $t(10)= 2.22$; $p=0.18$) (Figure 4).

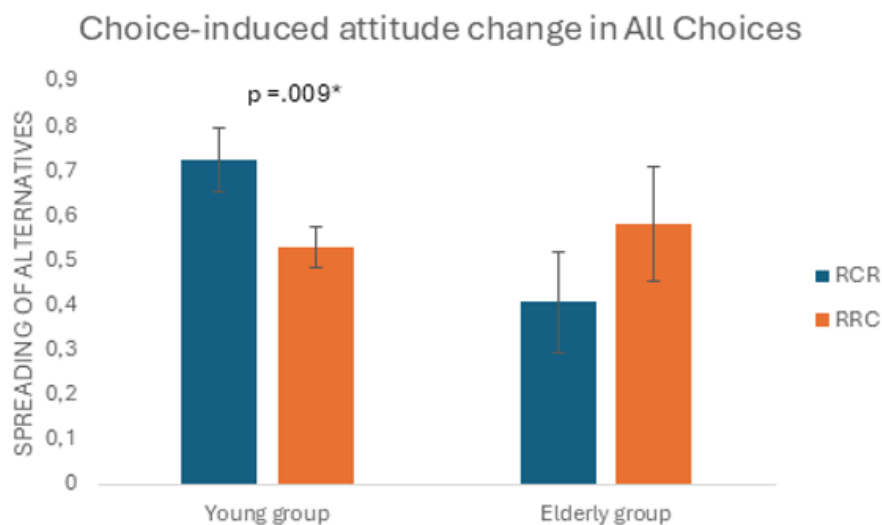


Figure 4. Performance of the two groups of participants in choice-induced attitude change in all overall choices; error bars indicate the standard error of the mean.



Remembered vs. not remembered choices

The young group showed a significant choice-induced attitude change in remembered choices (RCR=1.10, RRC=0.7; $t(21)=2.07$; $p=0.006$), but not in not-remembered choices (RCR=0.40, RRC=0.30; $t(21)=2.07$; $p=0.20$) (Figure 5.a) In contrast, the elderly group showed no change in attitude, neither in remembered choices (RCR=0.98, RRC=0.96; $t(10)=2.22$; $p=0.92$) nor in not-remembered choices (RCR=0.11, RRC=0.30; $t(10)=2.22$; $p=0.13$). (Figure 5.b)

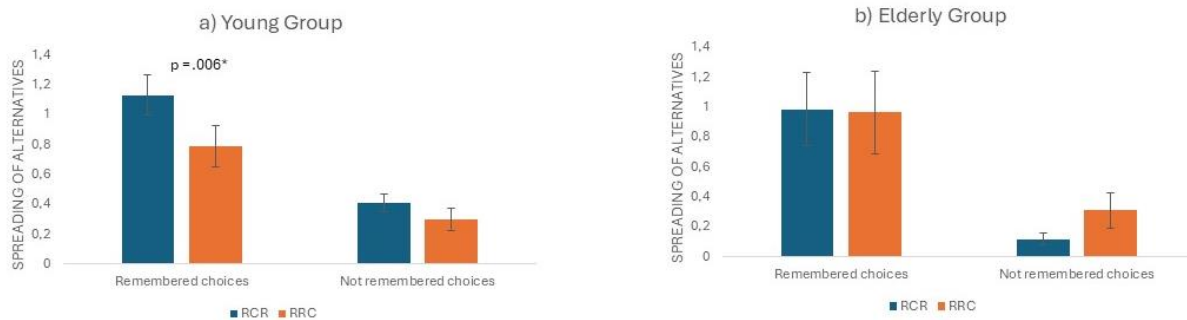


Figure 5. Performance in correctly remembered choices and not remembered choices; error bars indicate the standard error of the mean. a) Young group; b) Elderly group.

Discussion

The main result of this preliminary study revealed age-related differences among participants in memory and in choice-induced attitude change. Generally, elderly participants were less accurate than the young participants when they had to remember the choices they had made. Although the elderly participants of our sample were normal in their general cognitive functioning, they had poor performance in the memory test suggesting a decline in recognition memory age-related.

In the free-choice paradigm, when considering overall choices the younger subjects exhibited a significant choice-induced attitude change whereas the elderly participants did not. This result confirmed previous studies documenting that choice-induced attitude change is susceptible to aging (Ito et al., 2019; Huang et al. 2023).

Furthermore, we found an effect of memory in choice-induced attitude only in the young group but not in the elderly group. Young participants exhibited a significant choice-induced attitude change when they correctly remembered their choices, but not in not-remembered choices. Thus the memory of choices made seems to have favoured the reduction of cognitive dissonance in young people. This finding is in line with previous studies documenting a role for the episodic memory in CIPC (Salti et al.; 2014; Chammat et al. 2017). The same view is also supported by neuroimaging studies that documented the activation of brain areas linked to episodic memory, such as the hippocampus and the posterior parietal cortex, in the adapted free-choice paradigm (Chammat et al., 2017; Voigt et al., 2019).

In our study, the elderly participants did not present the CIPC in any case, neither remembering nor not remembering the choices made. The difference in the performance between young and elderly participants could not be explained in terms of familiarity with the images of destinations as revealed by our analysis on the familiarity test.



Our results are in contrast with the findings of the study by Huang et al. (2023). In their study, the adapted free-choice paradigm was employed including two different conditions, one with and one without reminders. Elderly participants showed less attitude change than young participants, only in the condition without reminder, thus without the involvement of episodic memory. After reminding the elderly of their previous choices, they showed CIPC comparable to young adults, as when information about previous choices is evident, cognitive dissonance becomes inevitable.

A possible explanation for our preliminary results may be related to how episodic memory is manipulated. In our study, a post-choice recognition task was used, where participants had to remember which images they had chosen or rejected in the different image pairs, during Choice1. This procedure should allow us to test, only at the end of the task, if the participants remembered more the choices that were subject to the CIPC and if episodic memory had favoured the reduction in dissonance shown between Choice1 and Rating2 (Chammat et al., 2017). In contrast, previous studies documenting the role of episodic memory in CIPC used a reminder condition, i.e., an explicit reminder of choices made during the Rating2 task (Salti et al, 2014; Huang et al., 2023). It is possible that explicitly stimulating memory during the rating task may help reduce dissonance in the elderly. This suggests that post-choice recognition and explicit choice reminders may play a different role in reducing dissonance.

Our findings seem more in line with the study of Lieberman and colleagues (2001). Here, we checked for the statistical artifact that was not considered by Lieberman et al. (2001), so our preliminary data seem to support the view that changes in subjective preferences are driven by mechanisms independent of episodic memory in elderly people.

Despite this, the spread of remembered choices showed in the elderly group revealed a similar, although non-significant, trend to that observed in the young group (i.e., $R_{CR} > R_{RC}$, see figure 5). This somewhat is in line with the findings of Ito et al. (2019). According to them, the elderly group would exhibit lower CIPC than the young one, even with memory stimulation by the reminder. This means that even when elderly individuals remembered their choices, they were less inclined to adjust their attitudes, so episodic memory would not be a key factor in stimulating CIPC in the elderly.

We emphasize that the sample size of the elderly group is smaller than the sample size of the young group and that perhaps this could explain the lack of statistical significance on this last result.

An alternative explanation of our findings is that episodic memory may not be the only factor facilitating CIPC. Other cognitive functions mediated by the frontal lobe and susceptible to aging such as executive functions, may be required for CIPC to occur. In this context, a previous tDCS study documented that in young people the left dorsolateral prefrontal cortex is necessary for choice-induced preference change by bringing attitudes into line with previous behaviour and thus resolving the conflict between actions and attitudes (Mengarelli et al., 2015). fMRI findings suggested that the ability to reduce dissonance mediated by the frontal lobe declines with age since elderly people exhibited less dACC activity during difficult choices. Although our elderly participants showed normal scores in the MMSE we did not test their executive function thus we cannot exclude a decline also in this cognitive domain.

Furthermore, in older adults, other emotional-affective factors could become more prominent in modulating CIPC (Baltes et al., 1990; Carstensen, 2006; Heckhausen et al., 2010). Indeed, previous



studies proposed that the lack of attitude change among elderly participants could be attributed to the higher levels of maturity and an increase in positive affect age-related (Ito et al., 2019; Huang et al., 2023). This suggests that elderly individuals may be more accepting of changes or may not perceive cognitive dissonance as strongly, as suggested by the Dynamic Integration Theory (DIT) (Labouvie-Vief et al., 2010). According to this theory, greater wisdom and an improved ability to regulate internal dissonance in the elderly may contribute to a reduction in the CIPC effect. Moreover, the elderly's reduced experience of regret could also reflect their diminished sensitivity to dissonance effects. Due to motivational and cognitive shifts toward positive affect, elderly adults may have greater skill in regulating emotions, such as regret (Västfjäll et al., 2011). When dissonant cognitions are made salient, through reminding, the amount of regret increases with the amount of dissonance (Festinger & Walster, 1964; Wicklund & Brehm, 2013). Reduced CIPC observed in elderly adults may reflect an emotional regulation strategy that helps them maintain positive emotional states when making complex decisions.

This preliminary study focused only on the role of memory as a cognitive factor facilitating CIPC. However, future studies incorporating measures of emotional and affective domains as well as executive functions, such as inhibitory control or decision-making processes, would provide a more comprehensive understanding of choice-induced attitude change, particularly in light of the critical role of frontal lobe functions in aging.

Competing interests

All authors declare no competing interests.

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