The Detrimental Impacts of Negative Age Stereotype on Episodic Memory of Older Adults: Does Social Participation Moderate the Effects?

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Abstract

Background: Memory performance among older adults can be influenced by negative age stereotypes. However, it is not clear if this effect influence episodic memory in an Asian sample. Furthermore, social participation has emerged as a potential protective factor for memory function as older adults could maintain or enrich cognitive functions when they are exposed to cognitively demanding environment. The purpose of the study was to examine the effects of negative age stereotype primes on episodic memory and the moderating role of social participation on the priming effect.

Methods: A total of 105 community-dwelling older adults residing in Hong Kong were randomly allocated to two experimental conditions. Participants were primed either with negative age stereotype words (n = 53) or neutral words (n = 52) by an implicit priming task. Episodic memory performance including total learning, two delayed recalls and a recognition task was investigated after the priming task. Analysis of Co-variance (ANCOVA) was used to test group differences in priming task and memory performance while a series of moderation analyses was performed to examine if social participation could moderate the priming effect.

Results: Results indicated that experimental group performed significantly worse than the control group among all measures in the memory performances. Follow-up analyses showed that socially active individuals might be less prone to the effects of negative age stereotypes in the recognition task.

Conclusions: Using a simple scale to measure social participation, we found that older adults who are more socially active might be more immune to the effects of negative age stereotype primes on episodic memory. These results provide initial support for social participation might act as an effective strategy against negative age stereotypes.

Trial registration: ClinicalTrials.gov: NCT04202120 (first posted December 17, 2019), (Retrospectively registered)

Introduction

Age stereotypes are beliefs concerning features of aged group [1]. They could be refined and amplified across the life span and could be manifested in both positive (e.g. wise and generative) and negative forms (e.g. unproductive and forgetful) [2]. These cognitive representations are powerful enough in impacting aged individuals once they feel and perceive as being the stereotyped group.

It is crucial to distinguish concepts between stereotype threat and priming with age stereotypes as they have been shown to affect differential outcomes in experimental designs. Jamieson and Harkins [3] alluded that stereotype threat induces motivation in particular in disconfirming the negative stereotypes while stereotype priming leads to poorer performance because participants withdraw efforts in outcome measures.

The role of age stereotypes on memory performance among older generation has been investigated by different methods. Priming has been one of the prevalent ways to activate such age stereotypes. The activation of certain stereotypes could be initiated either explicitly or implicitly in experiments. For example, negative age stereotypes were implicitly activated through a scrambled sentence task [4] or a priming task which was framed as a reaction time task [5]. The effects resulted by implicit activation of age stereotypes tended to be more powerful [5]. Experimental studies generally suggested that activation of negative age stereotypes poses detrimental effects in performances across various domains such as physiology [6]; physical ability in terms of walking ability [7]; and more importantly, memory performances [5].

The impacts induced by implicit activation of negative age stereotypes could be explained by Stereotype Embodiment Theory (SET). With reference to SET, age stereotypes are internalized through assimilating with corresponding culture across life span, and they would become salient from self-relevance [8]. The internalization of age stereotypes are shown to be associated with differential outcomes comprising physical and functional health [9, 10]; subjective well-being [11]; physical activity and health seeking behavior [12] and will to live and survive [13].

Horton and colleagues [14] conducted a meta-analysis on investigating the effect of priming age stereotypes on aged adults and the overall weighted effect size yielded as $d = .38$. Among different conditions, it is found that the negative age stereotype exerts nearly three times greater than positive age stereotype does, despite that both types do impact on performance measures [15]. Furthermore, implicit priming effect was found to be more powerful than explicit priming effect on memory performance and that is more salient when stereotyping cues are task-relevant [16, 17]. Based on the review, although both positive and negative age stereotypes could be activated, it is seemingly the effects of negative age stereotypes on memory performances outweighed those of positive age stereotypes. Thus, we only included negative age stereotype primes and neutral word primes for the priming task in the current study.

To replicate the findings from previous studies, we chose to investigate episodic memory by using The Hong Kong List Learning (HKLLT) as it is a comprehensive tool allowing researchers in dissecting performance differences in different stages [18].

Cultural differences on the prevalence of age stereotypes have also been found in the literature. Generally, it is reported that the perception of older adults tended to be more positive in the East than the West due to its cultural values including Confucianism and respect [19]. Although Asia culture comprises Confucius on humbleness, compliance and harmony, some studies have shown that older people living in urban setting rated more negatively in self-perception of ageing than did the others [20]. The emerging negative view could be attributed to modernization, allowing the older adults to compare themselves with the others whom they perceived as better-off. The persistent negative view of ageing could further loop and strengthen the vicious circle which directly or indirectly promotes negative age stereotypes. Thus, it could be asserted that the negative age stereotypes are rampant in Asian culture.

Rising evidence from studies have supported that cognitive performances could be influenced by psycho-social factors [21]. It is argued that social systems provide opportunities for psychosocial mechanisms including social support and social engagement that impact individuals behaviourally, psychologically and physiologically [22]. Highly socially integrated individuals were able to develop positive self–perception of ageing. It is found that older adults with more negative perception of ageing would tend to participate less in the society [23]. On the contrary, socially active individuals could develop larger social network and make more social contacts with others and those who possess a variety of interests in various activities also reported more positive self-perception of ageing [24]. Social engagement or social participation is believed to be one way for older adults to facilitate socialization and develop positive emotional and cognitive well-being. Thus, older adults with higher social participation rate are expected to possess fewer negative age stereotypes, its concomitant effects would be reduced. Concurrently, it is predicted that the priming manipulation should pose less impact on the cognitive performances among relatively socially active participants.

As reviewed, previous studies have been done on consolidating the relationship between priming negative age stereotypes and performance outcomes, yet, there are far fewer studies done in Asian context where societal values on older individuals are changing [25]. In this study, we examined the effects of negative ageing stereotype primes on episodic memory using implicit priming task. To date, to our knowledge, this was the first experiment using implicit priming task on looking into the effects of ageing stereotype on memory performance among older adults in Hong Kong. It also suggested a potential indicator, social participation, as a buffer against the negative age stereotypes.

With reference to the above literature, it is estimated that negative age stereotypes are present in older adults in Hong Kong. We first predicted that aged adults primed with negative ageing stereotype would perform worse in memory task than the control group. Specifically, we predicted that aged adults in experimental group would learn poorer, recall fewer words in delayed recall sessions as well as recognized fewer words in recognition task than the control counterparts. Moreover, it is postulated that the relationship between priming manipulation and memory performance would be moderated by social participation as operationalized as frequency of joining activities.

Method

Participants

Most of the participants were members of the Institute of Active Ageing of the Hong Kong Polytechnic University. The experiment was first promoted by the institute using internal email system and participants were recruited through phone calls. Other participants were recruited by referrals through snowball sampling. This study targeted young-old whose aged 60 years or above. The recruited participants were generally well-educated, physically healthy (self-reported), mentally healthy (using The Montreal Cognitive Assessment (MoCA)) and were able to read or speak fluent Chinese/Cantonese. A prior power analysis was performed that a total sample size of 92 subjects were required to have 95%

power for detecting an effect size of .38 (as reviewed in meta-analysis) when taking α = .05. 110 participants were drawn from the recruiting pool to take part in the study to avoid data loss.

Participants were blind to the assignment of conditions and were randomly assigned, according to number of participation trial using simple randomization, to either neutral word prime group (control group) or negative age stereotype prime group (experimental group). The random assignment procedure was done by the research team by generating random number. Participants were given $200 (~USD$25) supermarket coupon after completion of the experiment.

Design

The present study was a between-subject design where participants were randomly assigned to either one of the two conditions.

The priming task is adopted and modified from previous study [5, 26]. It was performed using the E-prime 2.0 software [27]. To ensure the primes flashed on screen were beyond awareness, the similar adjustment procedure was taken (see [26]). The individualized stimulus onset asynchrony (SOA) was determined in each trial block in which a total of ten neutral words will be flashed either 1 cm above or 1 cm below the cross-point (centre) in each trial. Participants were required to focus on the cross-point and to respond to the computer by pressing the designated keys as quick and accurate as possible. Patterned masks (rows of at signs:@) were used before and after each flash of word. After the trial block, participants were asked to try to report any words viewed during each trial. Their SOA will be reduced or enhanced whenever 2 words or above were correctly reported or no single word could be reported respectively. The priming SOA for this study ranged from 32 ms to 208 ms (M = 98.70 ms. *SD* = 48.60).

Negative age stereotype primes were taken from Levy's study while neutral words were adopted from the most frequent word used in Chinese context [5]. To ensure the words are relevant to the Hong Kong elderly population, a list of 60 words (22 words are positive, 22 words are negative and 16 words are neutral) was generated, 16 participants who are aged between 50 and 69 rated each of the word according to its relevance to oneself in a 7-point Likert type scale ranging from 1 indicating *'very positively related to you'* to 7 *'very negatively related to you'* while the score of 4 referring to *'irrelevant to you'*. The negative words and neutral words rated with highest frequency were used in the priming task.

This study extended the priming procedure in which 4 blocks of 40 trials were presented at the individualized SOA. In the negative age stereotype priming condition, 40 trials consisted of (i) 12 negative age stereotype primes (repeated once); (ii) 2 highly rated negative age stereotype primes (i.e. dementia and clumsy) (repeated twice); (iii) 4 selected neutral words (besides, sentence, moreover and even) (repeated once). More specifically, 12 negative age stereotype primes and 4 neutral words would be presented twice and 2 highly rated negative age stereotype primes would be presented in four times which constitute 24 trials and 8 trials respectively out of 40 trials in each block. In the neutral condition, 4 blocks of the 40 neutral words were flashed randomly.

The priming procedure was intensified based on Levy's (1996) priming paradigm as we would like to exacerbate the priming effects as well as counter-balance the number of trials in each two blocks so as to avoid fatigue and tendency of pressing the same key.

During each trial, similar to the prior individualized procedure, participant was asked to indicate whether the stimulus was flashed above or below the cross-point. The typical flow of each trial is shown in Figure 1.

After responding to the 40th trial in each block, four emotional words (two are negative and two are positive) were randomly presented to the participants, they were asked to rate whether the targeted words are positive or negative. As suggested by previous studies, individuals who were negatively primed would tend to respond to the negative words in a quicker manner, which could be proved as the activation of negative stereotype in subliminal level [28]. The reaction time and correct rate of clicking the flashes were presented after finishing the whole task.

Measures

Montreal Cognitive Assessment (MoCA) was used as a baseline assessment. It is a 10-min test that evaluates several cognitive domains with a total score of 30. The Hong Kong version is validated and is available at the MoCA official website [29].

The HKLLT is a validated tool for assessing episodic memory for aged Chinese speaking adults [18]. It is also further taken for investigating differences among older adults with normal cognitive ability and older adults with mild cognitive impairment [30]. The random control list was taken in this study. It comprises 16 words formed by four categories: *family member (grandmother)*, *country (Chile)*, *furniture (wardrobe)* and *vegetables (cucumber)*. All words were in random order such that no words within the same category were presented consecutively. Three attempts were presented to participants and the total learning score (out of 48) was computed over three trials. It also involved 10- and 30-minute delayed recalls as well as a recognition task. The recognition task requires participants to indicate a list of 32 items, half of them were targets while half of them were foils, in a yes or no manner. Discrimination score was calculated as it considered both correct hits and false alarm errors.

Socio-demographic information and a scale measuring social participation were included in a set of questionnaire. Self-rated health is measured using a single item ranging from 1 '*very good'* to 5 '*very poor'*. Expenditure is captured by the perceptual item 'Do you have enough money for daily expenditure?'. Participants were asked to rate this item ranging from 1 '*very insufficient'* to 5 '*more than enough'*. Social participation was measured by a list of 10 activities based on the proposed inventory (see Appendix A) [31]. Participants were asked to indicate the frequency of each activity on a 6-point Likert-type scale ranging from 0 '*never'* to 5 '*always'* within the past month. The average score of this scale was used for analysis, with greater score indicating higher rate of social participation.

Procedure

The experiment was done in the laboratory setting and it was divided into three sections: (i) pre-priming test, (ii) the priming task & (iii) memory assessment. The experiment lasted for around 2 hours and its research flow was presented in Figure 2. Participants first completed informed consent followed by the MoCA and simple visual acuity test using “Tumbling E” Eye Chart. The simple visual acuity test was chosen to ensure participants did not possess severe problems on eye-sight so that they were able to perform the priming task on the computer screen [32]. Then participants entered the trial session for determining personal SOA before the priming stage. This stage was framed as a reaction time test in which they were asked to press the appropriate key as accurate and fast as possible using their individualized SOA. This deceptive note was also put on the information sheet in order to avoid contamination of the present priming task. Participants started the priming task according to the allocated randomized treatment.

The HKLLT was implemented immediately after the priming task. All task instructions were standardized and computerized according to the manual of HKLLT via using E-prime 2.0. During the first learning trial, participants first listened to the 16 target words and were asked to record the words aloud to the microphone. No feedback was gained by the examiner or the computer. The procedure was repeated in the second and third learning trials. Participants were also asked whether they have been using any strategic methods to memorize those words.

After the learning trials in the HKLLT, participants were asked to fill a set of questionnaire including socio-demographic information and other scales such as frequency on social participation. Without prior notification, the participants were asked to stop filling the questionnaire and asked to recall the list of words again after 10 minutes and 20 minutes further (i.e. 30-minute delayed recall). The recognition task was immediately performed. The remaining time will be given for completion of questionnaire if necessary. After signing the receipt of coupon collection, the debriefing session was given in which the research flow was explained. Participants were also asked not to confide any details of the study.

Planned analyses

Analyses were performed using SPSS, version 25. Multiple independent samples *t* tests and chi-square independence tests were done on investigation of differences in socio-demographic characteristics and baseline assessments. Analysis of Co-variance (ANCOVA) was used to test group differences in priming manipulation and memory performance.

Since the 10-minute and 30-minute delayed recall score were highly correlated ($r = .89$), we computed one composite score (Total delayed recall) by adding two delayed recall scores. The total learning score, total delayed recall and discrimination score in recognition trial were taken as dependent variables while the average score of social participation frequency was taken as moderator for moderation analyses using the SPSS macro PROCESS (model 1) [33]. This is taken for analyses since it allows researchers use continuous variables for moderators as well as probing the interaction, if any, by using Johnson-Neyman (JN) technique.

Results

Baseline Measures

Socio-demographic variables

We recruited 151 potential participants in this study, 41 of them were excluded as they were not meeting the inclusion criteria (aged below 60) or rejected to come after consultation. The remaining pool of participants was evenly and randomly assigned to either experimental condition or control condition. 5 participants in both groups were excluded in analysis as they reported that they did not take any strategy during learning trials in the memory test.

No significant differences between groups was found, socio-demographic information across primed group was presented in Table 1. Age, gender, education years and health status would be taken as covariates for further analyses.

Montreal Cognitive Assessment (MoCA)

MoCA is used as a brief and potential screening tool for detecting Mild Cognitive Impairment (MCI) and Alzheimer's Disease (AD) has been validated in Hong Kong. A sum score of less than 22 is considered as a cut-off in Hong Kong [34]. All participants passed this cut-off (M = 27.55, SD = 1.46). Results showed that there was a marginally significant difference between priming task group on MoCA score [t (103) =1.79, p = .076], the MoCA score was controlled as covariate for further analyses.

Priming Manipulation

As the priming task was framed as a reaction task, the percentage of correct hits and response time will be shown at the end of the task. The individualized SOA might act as a critical factor in affecting the priming task and its reaction time for hitting the targets. Referring to Table 2, there were no differences found in the manipulation of personalized SOA [t (103) = -1.30, p = .198], the percentage of correct hits of target during priming [t (84.01) =.191, p = .061] as well as the reaction time for hitting each priming target [t (103) = -.30, p = .766].

Emotional Word Reaction Time

As discussed, it is reasoned that the time responding to negative words would be shortened if negative primes are activated in experimental group. Our finding of average reaction time to emotional words supported this argument after controlling baseline reaction time, MoCA score and socio-demographic variables. ANCOVA results suggested that experimental group significantly reacted faster to negative emotional words than did the control [F (1, 97) = 5.81, p =.018, ηp^2 =.06], indicating a possibility of activating negative age-stereotypes during the priming task. More interestingly, they also rated significantly slower to positive emotional words compared to the control group [F (1, 97) = 18.52, p <.001, ηp^2 =.16].

Further analyses were conducted to investigate whether social participation would moderate the effects of priming task by controlling the baseline reaction time, MoCA score and other co-variates of individuals. Referring to Table 3, results revealed that there was a significant main effect of priming manipulation on reaction time to positive emotional words after controlling all co-variates (B = 438.14, t =3.14, p =.003, CI =153.27, 723.00). As shown in Figure 3, the interaction effect of priming manipulation and reaction time to positive emotional words by social participation was found to be significant (B = -109.62, t =2.04, p =.045, CI =-216.57, -2.66), suggesting that participants in experimental condition who were relatively less socially active showed a longer reaction time in rating positive emotional words. All the regression weights were found to be non-significant in the relationship between experimental condition and reaction time to negative emotional words as well as the moderation analysis.

Memory Performance in HKLLT

Scoring and clinical findings of the HKLLT could be retrieved from previous studies [35]. The mean scores of each learning trial, total learning scores, 10-minute and 30-minute delayed recall as well as discrimination score of recognition task are shown in Table 4. Controlling the baseline MoCA score and other co-variates, control group learnt significantly more words in total learning trials [F (1, 98) = 15.01, p <.001, ηp^2 =.13], recalled more words in 10- and 30-minute delayed recall [F (1, 98) = 46.86, p <.001, ηp^2 =.33; F (1, 98) = 48.14, p <.001, ηp^2 =.33] and performed better in recognition task than the experimental group [F (1, 98) = 14.55, p <.001, ηp^2 =.13]. Furthermore, the rate of forgetting in the first 10 minute was computed by the suggested formula as [(10-minute delayed recall – learning trial 3)/learning trial 3 x 100%] [35]. ANCOVA results indicated that experimental group made more intrusion errors [F (1, 98) = 28.64, p <.001, ηp^2 =.23] and had a significantly higher rate of forgetting [F (1, 98) = 14.66, p <.001, ηp^2 =.13] than the control group.

Moderation analyses on memory performances

Table 5 showed the results of moderation analyses between experimental condition and memory performances. Results revealed that the interaction effects of priming manipulation on total learning and total recall by social participation were non-significant (ps > .05). However, there was an interaction effect of priming manipulation by social participation found in discrimination score in recognition trial (B = 7.83, t = 2.13, p = .036, CI = .52, 15.14), suggesting that participants who were relatively less socially active performed worst compared to other counterparts. In other words, those who were negatively primed but socially active did relatively equal to the control group as shown in Figure 4. Taking Johnson-Neyman (JN) technique to probe this interaction, the output identified individuals with .71 standard deviation on social participation (above which 24.76% of our samples) would not be affected by the negative priming manipulation.

Discussion

This study examined how implicitly priming negative age stereotype could induce detrimental effects on memory performance among older adults in Hong Kong and our results replicated previous studies as reviewed. Participants were primed with negative aged-based stereotypes in experimental group and these stereotypes were assumed to be activated under subliminal level as indicated by the shorter reaction time to negative but longer reaction time to positive emotional words in experimental group.

Concerning the priming manipulation, socially less active participants who were primed with negative age stereotypes showed a longer reaction time in rating positive emotional words. However, for negative emotional words, there was absence of moderating effect. This could be possible that after activation of their own negative perceptions of ageing, when they were asked to rate positive emotional words, those who were relatively active were assumed to possess less negative age stereotypes so that the response time to positive emotional word remained similar, but those who were less active and with more negative view of ageing might need to spend cognitive resources on counteracting for reducing self-doubt or worries [36]. Moreover, it could also be argued that when negative age stereotypes were activated, presenting contradictory words (i.e. positive emotional words) might saliently induce self-doubt, this reduced their availability of resources of performing reaction time tasks as well as subsequent memory tasks.

Our study also supported our hypothesis that negative age stereotypes could impact on memory performances of older adults. The present results were consistent with studies done in both Asian and Western countries [5, 37]. HKLLT is an essential tool in dissecting the whole process of memory task including stages of learning, recalling and recognizing. Throughout the procedures, our results consistently evidenced that the experimental group did poorer than the control group in all stages after controlling their baseline performances and other covariates. It could be argued that negative age-based stereotype primes would interfere the working memory of participants in all stages. The availability of resources on performing the memory tasks was reduced, therefore, they learned worse than their counterparts even sematic organization was taken as an effective strategy. Furthermore, it could be sensible that they performed relatively poorer as they withdrew efforts after the activation of age stereotype primes [3]. This underlying mechanism might be reflected by the triad results among experimental group on higher forgetting rate, fewer correctly recalled words as well as greater chance of making intrusion errors.

Our results partially supported participants who were negatively-primed but with greater social participation would be less affected, although this effect was significant only in the relationship between priming manipulation and recognition scores. It could be possible that negative age stereotypes are too compelling after the priming task, so that during the learning and recall sessions, participants might spend cognitive resources to resist or cope with the withdrawal effect. However, after a period of time (i.e. an hour after priming task), the experimental effect faded and those who were socially active might counter-off the activation effects of negative age stereotypes and performed almost equally well as the control subjects.

Another possible interpretation is related to the nature of the memory test. The present studies showed that the magnitude of effect was stronger in delayed-recall tasks than the recognition tasks. Recall and recognition involve differential mechanisms in processing and recognition task is generally considered to be less demanding [38]. Delayed recall process is a more self-initiated process which demands participants more cognitive efforts relative to recognition tests which rely more on situational and environmental cues. Research generally supported that both processes involved brain activation in the area of right pre-frontal cortex and the anterior cingulate, yet, compared to recall, recognition had higher activation in the right inferior parietal cortex, providing evidence that both processes involved in the two modes of episodic retrieval [38]. The activation of negative age stereotypes might exert greater negative force on the recall task; this might explain why the moderation effects were non-significant in delayed recall tasks but became significant in recognition task that was relatively less demanding [39].

A large body of research indicated the positive impacts of social participation on physical and psychological well-being of aged adults, productive and social activities are found to be the key variables associated with subjective and psychological well-being among older generation [40]. The number of participated social activities was also found to be significantly and positively associated with mental status and memory [41]. Furthermore, the quality of the social activity participation also played an essential role in enhancing the quality of life of the elderly after retirement [42, 43]. Another study evidenced that elderly who participate more frequently in community social activities scored lower in the Negative Ageing Stereotypes Assessment Questionnaire, researchers argued that elderly who participate less in daily life are more prone to suffering negative beliefs about social contacts, which further foster the risk of suffering health, cognitive and mental problems [24]. This study might provide a possible intervention for future study that social participation might act as an effective strategy against negative age stereotypes.

Our study contributes to the literature as it is claimed that the number of study using subliminal experimental conditions of age stereotypes is meagre. Comparable and more systematic results are presented in our study by analysing the whole learning progress, recalling and recognition process. Moreover, we also modified and extended the priming procedures as we believed that the degree or duration of stereotype threat exposure might affect the memory performances to a certain extent. Our results showed that experimental group did worse in both delayed recall tests and recognition test, it might serve as a preliminary evidence claiming longer duration of exposure to negative age stereotypes could induce relatively stronger effects leading to higher detrimental impacts on both tests. Future studies could be carried out on how negative age stereotypes could affect memory performances by varying the intensity and/or duration or primes.

There are a few limitations in the current study. One of them is that our participants are relatively educated and they scored relatively high in the MoCA test. Previous study indicated negative age stereotypes could be more destructive among young-olds and participants with higher education although it was using stereotype threat manipulation [4], the strong effect of priming manipulation of this

study could be justified. Yet, those who are older and with relatively lower education background might need further investigation.

Another limitation concerns our findings, although there was a preliminary result supporting that relatively socially active aged adults were less likely to be impacted in the memory test, this effect was found to be significant only in recognition task of the memory test. There could be possibilities that socially active individuals could possess fewer negative age stereotypes, but the effects would be more or less similar once some saliently particular negative age stereotypes were activated. Future study could try to explore whether there could be specific negative age stereotype primes that exert specific impacts on performance outcomes.

Conclusions

To sum up, by including a neutral group, this study replicated and extended the investigation on how priming negative age stereotypes affected the whole process of memory performance using implicit priming manipulation among aged adults in Hong Kong. We also added a possible potential indicator, frequency of social participation, as a moderator on this effect. That is, social participation might not just act as a booster for well-being of aged adults, but also might be a potential strategy against the detrimental effects of negative age stereotype primes.

Declarations

Ethics approval and consent to participate: This study was approved by the Human Subjects Ethics Application Review System of The Hong Kong Polytechnic University (HSEARS20170227009).

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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List Of Abbreviations

Stereotype Embodiment Theory (SET)

Montreal Cognitive Assessment (MoCA)

Stimulus onset asynchrony (SOA)

The Hong Kong List Learning Test (HKLLT)

Analysis of Co-variance (ANCOVA)

Alzheimer's Disease (AD)

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Tables

Table 1. Socio-demographic information of the participants across groups

	Experimental group (n = 53)		Control Group (n = 52)		Statistics			
	Percentage	Mean (*SD*)	Percentage	Mean (*SD*)	*t*	*χ2*	*df*	*p*
Age		65.40 (3.10) (range: 61-71)		65.15 (2.55) (range: 56-71)	-.44	/	103	.66
Gender (Male)	50.9%		48.1%		/	.09	1	.77
Education (in years)		12.96 (2.67)		13.46 (2.85)	.93	/	103	.36
Marriage (Married)	69.8%		78.8%		/	1.12	1	.29
Income ($)					/	6.47	3	.09
< 6000	47.2%		34.6%					
6000-14999	34%		26.9%					
15000-24999	7.5%		25.0%					
25000 or above	11.3%		13.5%					
Job status					/	1.23	1	.27
Retired	83%		90.4%					
Unemployed or with a part-time job	17%		9.6%					
Expenditure (out of 5)		3.19 (.86)		3.42 (.70)	1.54	/	103	.13
Self-rated health (out of 5)		3.11 (.78)		2.87 (.93)	-1.48	/	103	.14
Social participation (out of 5)		2.48 (.70)		2.65 (.64)	1.31	/	103	.19

MoCA score	27.30 (1.34)	27.81 (1.55)	1.79	/	103	.08

Table 2. Priming information across groups

	Experimental group (n = 53)	Control Group (n = 52)	Statistics			
	Mean (*SD*)	Mean (*SD*)	*t*	*F*	*df*	*p*
Individualized SOA (ms)	103.24 (41.34)	92.92 (40.21)	-1.30	/	103	.198
Correct hits (%) #	97.66 (2.78)	98.50 (1.62)	1.91	/	84.01	.060
Reaction time (ms)	497.03 (129.91)	490.10 (106.22)	-.30	/	103	.766
Reaction time to negative emotional words	974.45 (154.94)	1053.03 (212.52)	/	5.81	97	.018
Reaction time to positive emotional words	996.35 (258.31)	816.12 (137.76)	/	18.52	97	<.001

Note

Degree of freedom is adjusted due to violation of homogeneity assumption

Table 3. Moderation analyses of social participation between experimental conditions and reaction time to emotional words

Outcome: Reaction time to positive emotional words, R^2 = .24, MSE = 41759.88						
Variables	*B*	*SE*	*t*	*p*	LLCI	ULCI
Experimental group	438.14	143.49	3.05	.003**	153.27	723.00
Social participation	32.34	40.48	.799	.426	-48.03	112.71
Experimental group*Social participation	-109.62	53.88	-2.04	.045*	-216.57	-2.66

Note. *$p < .05$, **$p < .01$, ***$p < .001$

Table 4. Memory performance across groups

	Experimental group (n = 53) Mean (*SD*)	Control Group (n = 52) Mean (*SD*)	Statistics *F*	*df*	*p*	η_p^2
Learning trial 1	6.36 (1.77)	7.23 (1.91)	3.44	98	.07	.03
Learning trial 2	9.43 (1.81)	11.04 (2.14)	14.47	98	<.001	.13
Learning trial 3	11.23 (2.02)	12.90 (1.67)	17.02	98	<.001	.15
Total learning	27.02 (4.72)	31.17 (5.06)	15.01	98	<.001	.13
10-minute delayed recall^	8.81 (2.33)	11.90 (2.14)	46.86	98	<.001	.32
Rate of forgetting	-20.95 (19.83)	-7.97 (9.77)	14.66	98	<.001	.13
30-minute delayed recall^	8.79 (2.59)	12.08 (2.31)	48.14	98	<.001	.33
Total intrusion errors	4.17 (2.99)	1.38 (1.57)	28.64	98	<.001	.23
Discrimination score of recognition	77.12% (17.07)	89.18% (9.68)	14.55	98	<.001	.13

Note. ^ out of 16 words

Table 5. Moderation analyses of social participation between experimental conditions and memory performances

Outcome: Discrimination score, R^2 = .39, MSE = 150.87

Variables	*B*	*SE*	*t*	*p*	LLCI	ULCI
Experimental group	-29.75	9.81	-3.03	.003**	-49.22	-10.29
Standardized social participation	2.59	2.77	.94	.352	-2.91	8.08
Experimental group*Social participation	7.83	3.68	2.13*	.036*	.52	15.14

*p < .05, **p < .01, ***p < .001

Figures

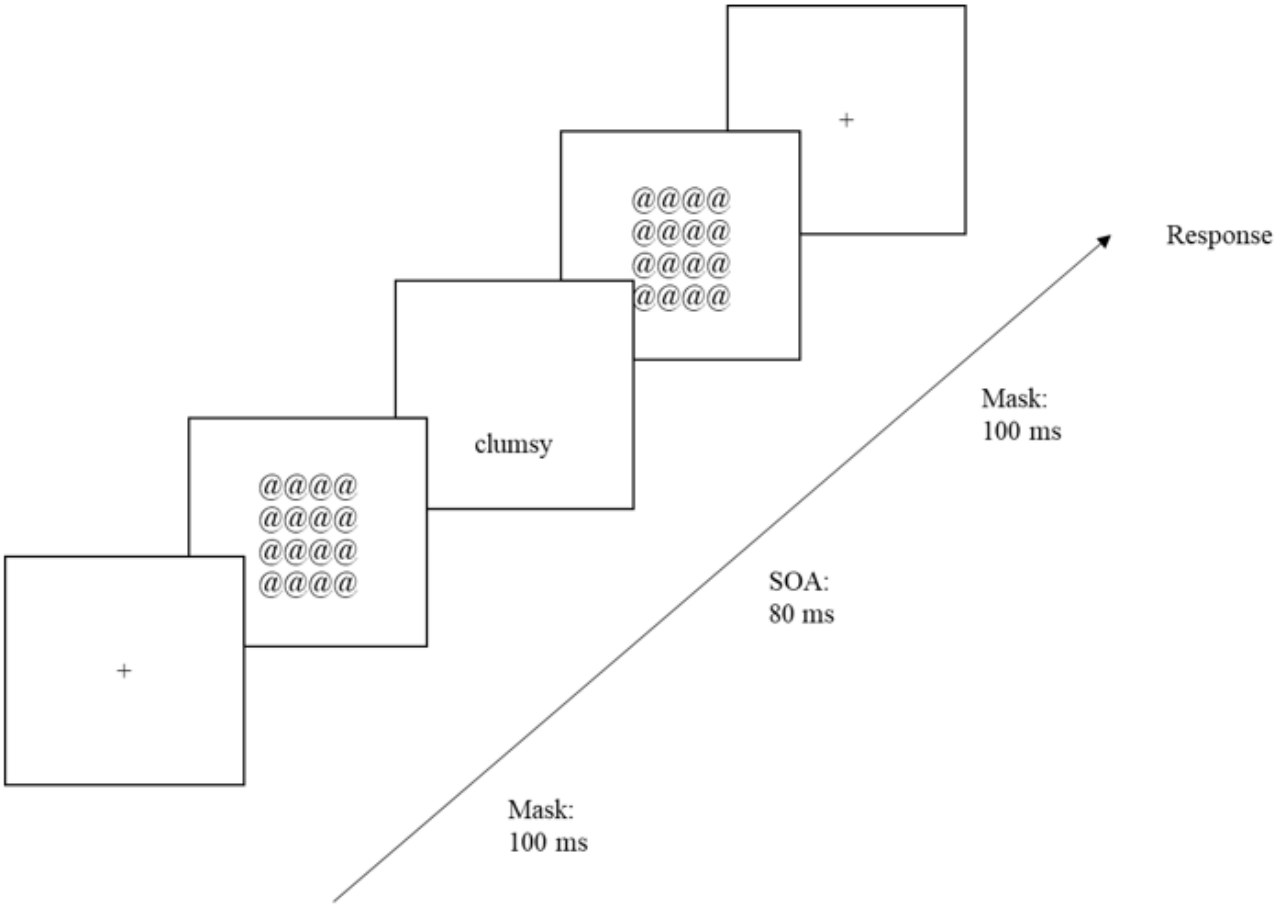

Figure 1

An example of the flow of the masked priming for one typical trial

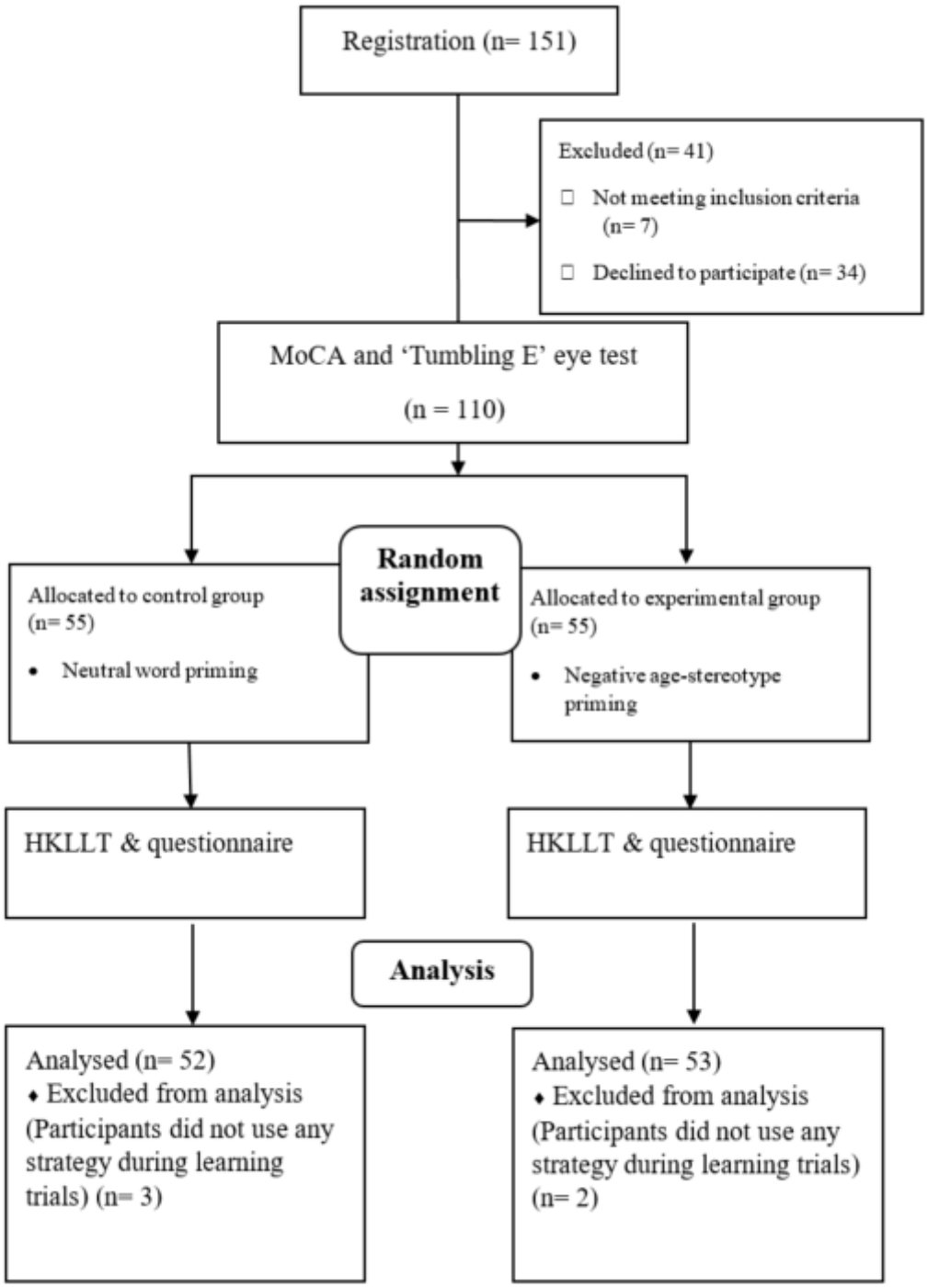

Figure 2

Research flow of the present study

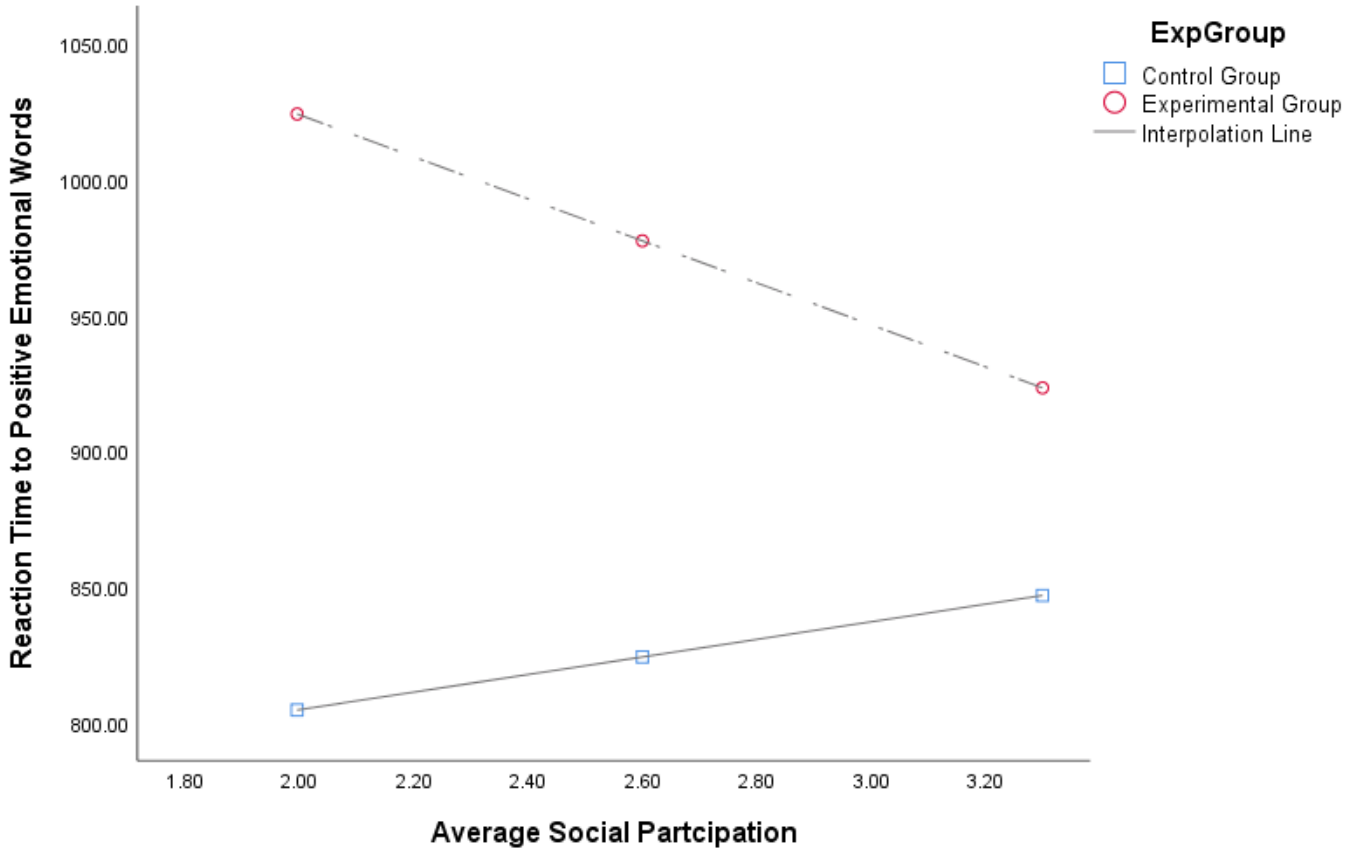

Figure 3

Moderation effect of social participation between experimental group and reaction time to positive emotional words

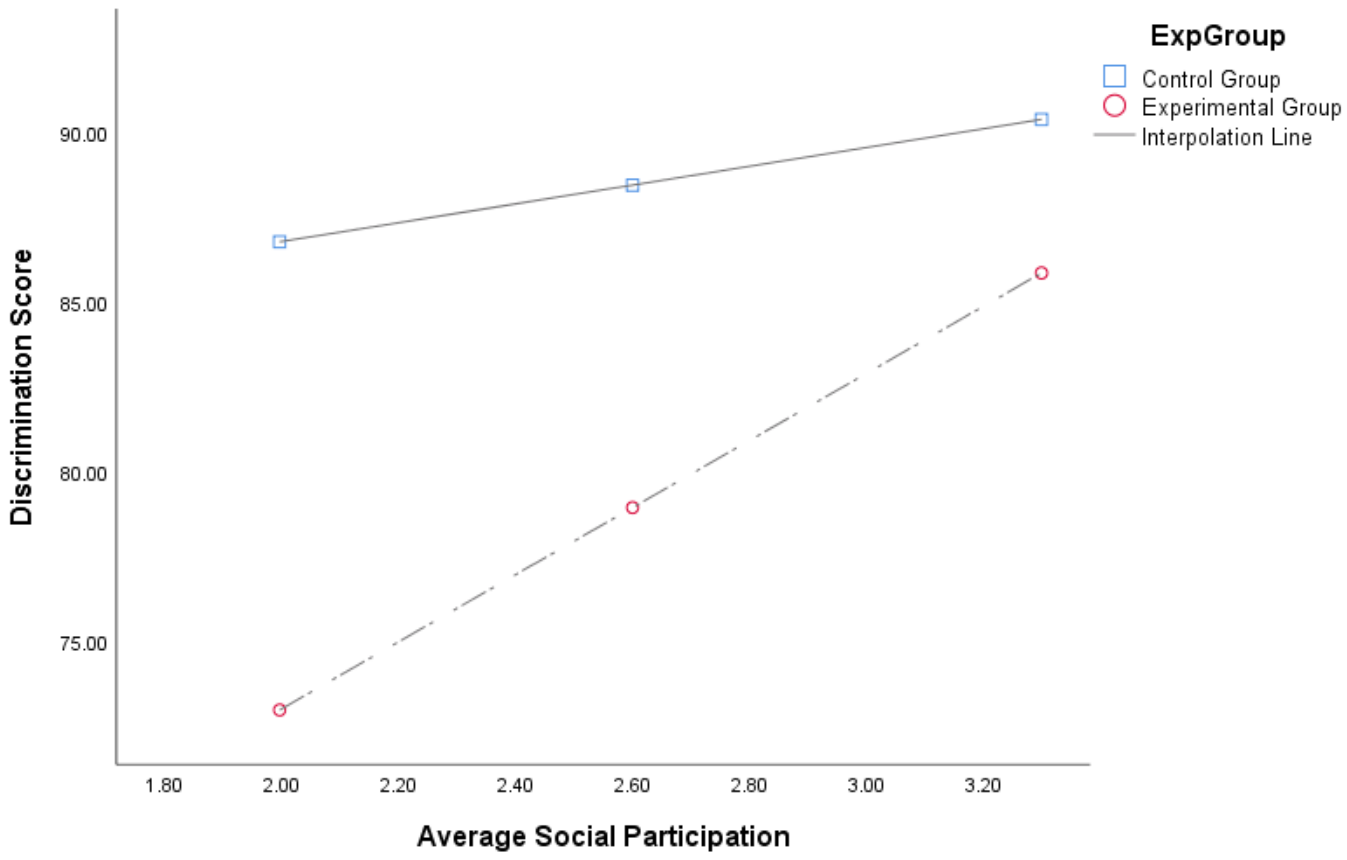

Figure 4

Moderation effect of social participation between experimental group and recognition trial performance

Supplementary Files

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