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Cultural differences in susceptibility to stereotype threat: France vs. India.

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Abstract

Objectives

Negative aging stereotypes make older adults perform below their true potential in a number of cognitive domains. This phenomenon, known as Age-Based Stereotype Threat, is currently viewed as a powerful factor contributing to an overestimation of cognitive decline in normal aging. However, age-based stereotype threat has been investigated almost exclusively in Western countries. Whether this phenomenon is universal or culture-specific is unknown.

Methods

Here, we first ran a pilot study ($N=106$) in which we assessed French and Indian participants' attitudes towards aging. Then, we assessed stereotype threat effects on arithmetic problem-solving performance and strategies in French and Indian older adults ($N=104$).

Results

We found that French older adults have more negative implicit attitudes towards aging than Indian older adults. We also found that culture modulates age-based stereotype threat effects. Whereas French older adults experienced stereotype threat on both selection and execution of strategies on all arithmetic problems, Indian older adults experienced this threat only in their strategy selection on harder problems. Most interestingly, cultural differences emerged on arithmetic problems under stereotype threat condition, where otherwise no cultural differences were found in the control condition.

Discussion

Our findings have important implications for understanding how cultural contexts change aging effects on human cognition and age-related difference in cognitive performance.

Keywords: aging, age-based stereotype threat, cognition, arithmetic, strategy

Cultural differences in susceptibility to stereotype threat: France vs. India

Negative stereotypes about older adults (e.g., beliefs that older adults are necessarily slow, incompetent, and senile) are pervasive (Cuddy, Norton, & Fiske, 2005). However, these stereotypes may differ across cultures. Some cultures, like Eastern cultures, honor, obey, and admire older people, as well as have great respect for their wisdom presumably accumulated via life experience. Such values may lead to less negative age-based stereotypes (e.g., Sung, 2001). Consistent with this, some studies found more positive views of older adults in Eastern countries (e.g., Levy & Langer, 1994; Yoon, Hasher, Feinberg, Rahhal, & Winocur, 2000), although other studies found more negative attitudes in Eastern cultures (e.g., Luo, Zhou, Jin, Newman, & Liang, 2013; North & Fiske, 2015) or mixed attitudes (Vauclair, Hanke, Huang, & Abrams, 2017). In addition, there is evidence that negative aging attitudes have deleterious consequences for healthy and active aging due to greater experience of age discrimination and internalization of aging stereotypes (for a review, see Swift et al., 2017). The present study focused on Indian participants, because several studies indicate that older adults in India enjoy a respectful status in the family and receive economic support (Brijnath, 2012; Lamb, 2013; Sudha, Rajan, & Sharma, 2004) and other inter-Asian and cross-cultural studies (Hall, 2019; Sakamoto et al., 2017) show positive attitudes towards aging and higher subjective quality of life among Indian older adults.

Many studies showed that older adults' cognitive performance decreases when older adults experience the threat of being judged as cognitively impaired due to aging (Barber, 2017; Lamont, Swift, & Abrams, 2015). Effects of age-based stereotype threat have been found in a wide variety of cognitive domains and with different experimental procedures. However, the majority of research investigating the effects of negative stereotypes on older adults' cognitive abilities are conducted in Western cultures (Henrich, Heine, & Norenzayan, 2010a; 2010b). Unknown is whether the phenomenon of age-based stereotype threat

documented among older adults from Western culture is normative (Henrich et al. 2010b). In the present study, we asked whether this threat affects older adults from non-Western culture. Showing that stereotype threat effects vary with culture and are smaller, or even non-existent, in cultures with positive attitudes towards aging would be important for several reasons. First, it would deepen our understanding of critical determiners of and mechanisms responsible for effects of age-based stereotype threat. Second, it would bring further evidence that, as assumed by Steele and Aronson (1995), stereotype threat effects are contextually driven and can be counteracted. Knowing that older adults in culture where aging attitudes are more positive can resist stereotype threat would provide interesting contextual cues from daily life to challenge negative aging stereotypes. Such an awareness is a necessary first step to help breaking prejudice habit (Devine et al., 2017). Finally, documenting effects of age-based stereotype threat cross-culturally contributes to shed important lights on how culture shapes cognition and influences cognitive aging.

Tan and Barber (2020) tested whether age-based stereotype threat occurred in older adults from the Chinese culture. They tested older Chinese participants' memory recall performance under stereotype threat or stereotype alleviation condition. That is, they presented the cognitive test as diagnostic of older adults' memory abilities in the stereotype threat condition and as non-age discriminatory or age-fair in the stereotype alleviation condition. They found poorer recall performance in the stereotype threat condition relative to the stereotype alleviation condition, exactly like in US participants. However, the Chinese participants in this study were immigrants residing in the United States. It is possible that Asian participants residing in Western cultures perform more like their western counterparts than participants who have resided exclusively in Asia. Consistent with this, in Tan and Barber's study, the magnitude of the stereotype threat effects in the Chinese participants was almost identical to that of the stereotype threat effects in the American participants. Thus,

effects of stereotype threat may be different in Asian participants who are still residing in an Asian country (see Liu Zhao, Zhang, & Dang, 2017, and Zhang, Lin, Gao, et al., 2017, for age-based stereotype threat effects in Chinese participants living in China; but see Levy and Langer, 1994, who found no aging effects on memory performance in Chinese participants' from mainland China, in contrast to aging effects in American participants).

Tan and Barber (2020) also tested a group of Chinese participants who prior to the stereotype manipulation were reminded of Confucian traditions of filial piety and who were told that these values had been transmitted to the younger generation. Interestingly, this group of participants did not exhibit stereotype threat effects. This suggests that stereotype threat effects might not be observed in older adults who are still residing in countries with less negative attitudes towards older adults. We tested this possibility by investigating the effects of age-based stereotype threat in French and Indian older adults who live in France and India, respectively.

Here, we compared stereotype threat effects in older adults from France and India. Older adults may be routinely subjected to effects of negative age-related stereotypes in France (Coudin, & Alexopoulos, 2010; Mazerolle et al., 2012), whereas studies indicate positive attitudes with older adults in India (e.g., Brijnath, 2012; Hall, 2019; Lamb, 2013; Sakamoto et al., 2017; Sudha et al., 2004). Given these differences in aging contexts between France and India, we expected cultural variations in age-based stereotype threat effects and assessed arithmetic performance of French and Indian older adults under stereotype threat or control conditions. This design helped us to answer several questions.

First, we were able to determine whether Indian older adults show similar age-based stereotype threat effects previously found on French older adults' arithmetic performance (Nicolas, Lemaire, & Régner, 2020). Second, using an arithmetic task which invariably relies on Arabic numbers, we secured leverage on participants' baseline arithmetic fluency. This

helped us to estimate stereotype threat effects in older adults from two different cultures while controlling for potential differences in their mathematical skills. Third, the arithmetic task (computational estimation, or finding approximate estimates to two-digit multiplication problems, like 42×69) can vary in difficulty (estimates are harder to find for some problems than others, and better strategy is harder to select on some problems than on others, like 21×24 vs. 74×89). This enables to determine whether cultural differences in age-based stereotype threat effects interact with problem types and task difficulty.

Another reason for using an arithmetic task comes from Nicolas et al. (2020)'s findings that stereotype threat effects in older adults' arithmetic performance exist independently of participants' baseline performance. They demonstrated this by comparing young and older adults on arithmetic tasks where age-related differences are either non-existent or smaller (Uittenhove & Lemaire, 2015, 2018). Interestingly, Nicolas et al. found stereotype threat effects when arithmetic tasks were presented as testing memory and attention. Given the success of this age-based stereotype threat manipulation with a task that usually shows no (or very small) age-related differences, we adopted this approach in the present study. Lastly, we were able to demonstrate and compare the mechanics of any performance decrement under stereotype threat relative to control condition, by adopting a strategy approach (Lemaire, 2016). This approach establishes that age-based stereotype threat effects occur via impairing French older adults' ability to select the better strategy on each item and/or to execute strategies efficiently (Lemaire, Brun, & Régner, 2018; Nicolas et al., 2020).

To the extent that cultural differences in stereotype threat effects on older adults' cognitive abilities are systematically associated to strategic variations, we can make inferences regarding how culture and aging influence cognition. Following Nicolas et al. (2020)'s study, we asked French and Indian participants to find estimates of two-digit

multiplication problems. For each problem, participants could choose between two-rounding strategies, one that was better and the other poorer on each problem. This enabled us to test our hypotheses and predictions regarding culture-related differences in effects of age-based stereotype threat.

Hypotheses and Predictions

The main hypothesis under test is that cultures with less negative views of older adults should show no or smaller effects of age-based stereotype threat. The main predictions of this hypothesis are interactions between culture and effects of stereotype threat on participants' performance and strategy choices. Effects of stereotype threat on participants' performance (i.e., more accurate estimates and faster speed in control than in stereotype threat condition) should be found in French participants, replicating previous findings (e.g., Nicolas et al., 2020; Lemaire et al., 2018). Moreover, these effects should be smaller, or even non-existent, in Indian participants who, relative to French participants, would obtain smaller performance differences, or even no differences, between stereotype threat and control conditions. Also, effects of stereotype threat on strategy use (i.e., smaller percentages of better strategy selection in stereotype-threat than in control condition) were expected to in French participants as in our previous studies, and either smaller or non-existent in Indian participants. Before presenting method and results of this study, we report a pilot study which assessed differences in implicit attitudes of aging between French and India participants.

Pilot Study

In a pilot study, we assessed cultural differences in French and Indian participants' automatic preferences for old versus young. Because implicit measures are less amenable to deliberate control unlike explicit self-report measures, we assessed participants' automatic associations using the Implicit Association Test (or IAT; Greenwald, McGhee, & Schwartz,

1998). IAT has been applied in a number of settings and proved very sensitive in detecting biases (for reviews see Nosek, Greenwald, & Banaji, 2007, and Kurdi et al., 2019).

IAT (Greenwald et al., 1998) measures the strength of automatic (implicit) associations between concepts in people's minds. It relies on latency measures in a simple sorting task. We used Age-IAT where participants responded to a series of items that were to be classified into four categories – two representing a concept discrimination (i.e., *young* versus *old*), and two representing an attribute discrimination (i.e., *good* versus *bad*). Participants responded rapidly to items representing one concept with a right-hand key press and one attribute (e.g., *old-good*), and with a left-hand key press to items from the remaining two categories (e.g., *young-bad*). Participants also performed a second task in which the key assignments for one of the pairs were switched (e.g., *young-good* and *old-bad*). The order of presentation was counterbalanced.

The IAT yields measures derived from latencies of responses to these two tasks. These measures are interpreted in terms of association strengths by assuming that participants respond more rapidly when the concept and attribute mapped onto the same response are strongly associated (“hypothesis-consistent” pairing; *old-bad* and *young-good*) than when they are weakly associated (“hypothesis-inconsistent” pairing; *young-bad* and *old-good*). The overall IAT effect (*D*-score)¹ is the standardized mean difference score between the “hypothesis-inconsistent” pairings and “hypothesis-consistent” pairings. The Inquisit Web 6 by Millisecond Software™ was used to host the IAT online and to calculate the IAT effect (*D*) using improved scoring algorithm (Greenwald, Nosek, & Banaji, 2003). Thus, a positive

¹ IAT effect (*D*), as explained by Greenwald et al. (2003), is the difference between the average response latencies between contrasted conditions divided by the standard deviation of response latencies across the conditions (distinct from the pooled within-conditions standard deviation). Functionally, it is an individual effect size assessment that is similar to Cohen's *d* except, with the same number of trials per condition, *D* has a theoretical minimum of -2 and a maximum of +2 when blocks of the same size are compared (Nosek & Sriram, 2006).

IAT score supported a stronger association between *young-good* and *old-bad* whereas a negative IAT score indicated a stronger association between *young-bad* and *old-good*.

One hundred six older participants from France ($N = 53$) and India ($N = 53$) completed the Age-IAT online. Age did not vary significantly across cultures ($M_{French} = 66.0$, $M_{Indian} = 68.0$, $F(1,104) = 2.49$, $p = 0.118$, $\eta^2_p = 0.02$). Interestingly, univariate ANOVA revealed significant differences between IAT scores (see Table 1) of French and Indian older adults ($M_{French} = 0.795$, $M_{Indian} = 0.429$, $F(1,104) = 12.49$, $p < 0.001$, $\eta^2_p = 0.13$). These findings suggest that Indian older adults hold less automatic preferences for young relative to old than do French older adults. Such findings raise the possibility that Indian older adults could be less susceptible to age-based stereotype threat effects in our main study.

Insert Table 1 About Here

Method

Participants

The target sample size was determined using an a-priori power analysis (G*Power; Faul, Erdfelder, Lang, & Buchner, 2007) with an assumed effect size (f) of 0.26. The assumed f value is an average of $d = .52$ (corresponding to $f = .25$) as found by Lamont et al. (2015) in their meta-analysis of age-based stereotype threat effects and $\eta^2_p = .07$ (corresponding to $f = .27$) as found by Tan and Barber (2020) in their study on stereotype threat among Chinese older adults. Using this reported effect size ($f = .26$), the error rate set to .05, and the power set to .80, the power analysis indicated that a sample of 119 participants would be ideal to detect the critical 2 (Group: French, Indian) x 2 (Condition: threat control) interaction. Due to inclusion criteria, our experimental design could include 104 participants (26 per condition). These were older adults from France ($N = 52$) and India ($N = 52$), who obtained a score > 27

in the Mini Mental-State Examination (*MMSE*, Folstein, Folstein & McHugh, 1975). Participants' level education was matched across both groups (see Table 2); all participants had received their education in their respective countries and, at the time of the study, were residing permanently in French and Indian metropolitan cities. Participants also took the arithmetic fluency test (French, Ekstrom, & Price, 1963), and were then randomly assigned to either a stereotype threat or a control condition. The target sample size could achieve at least 75% power to detect the critical 2 (Group: French, Indian) x 2 (Condition: threat control) interaction. Moreover, it was sufficient to further test interaction effects involving repeated measures, 2 (Group: French, Indian) x 2 (Condition: threat control) x 2 (Problems: easy, hard) to assess influence of age-based stereotype threat on participants' strategy use and execution of different problems.

The 2(Group) x 2(Condition) ANOVAs conducted on demographic variables (age and education) and arithmetic fluency indicated only a significant main effect of the Group on education ($F(1, 100) = 7.64, p = .007, \eta^2_p = .01$) and arithmetic fluency ($F(1, 100) = 23.49, p < .001, \eta^2_p = .19$), with Indian participants scoring higher ($M_{education} = 13.65, M_{arithmetic} = 93.10$) than French participants ($M_{education} = 12.54, M_{arithmetic} = 72.35$). No significant interaction effects emerged ($F_s < 1.0, p_s > 0.39$), indicating equivalence of participants between the four experimental conditions. However, as the cultural difference in arithmetic fluency may be critical when interpreting participants' performance under threat and control conditions, analyses were conducted with and without arithmetic fluency scores as covariates. Task instructions were given in French to French participants and in Hindi to Indian participants. French participants were born and raised in France and were recruited (and tested at home) by PN (the first author) via advertisements in senior citizen centers. Indian

participants were born and raised in India and recruited by PN's relatives who live in India; they were tested at home by PN, as PN knew none of them in person.

Insert Table 2 About Here

Experimental Task

Sixty-four two-digit computational estimation problems (e.g., 32×67) were used. Participants were told that every problem (e.g., 32×67) could be solved using either a rounding-down (RD) strategy (rounding both operands down to the nearest decades; 30×60) or a rounding-up (RU) strategy (rounding both operands up to the nearest decades; 40×70). Two types of estimation problems were used – easy and hard. For easy problems, the unit digits of both operands were either >5 or <5 (e.g., 34×62 or 38×69). For hard problems, the unit digit of one operand was >5 and the other <5 (e.g., 49×62). These problems were chosen as participants select the best rounding strategy more easily on easy than on hard problems (Lemaire, Arnaud, & Lecacheur, 2004). We also chose to test easy and hard problems, because previous studies found that stereotype threat effects are larger on harder (controlled) tasks than on easier (more automatic) tasks (e.g., Barber et al., 2020; Mazerolle et al., 2012).

Half the easy and hard problems were best estimated using the rounding-down (RD) strategy, and the other problems using the rounding-up (RU) strategy. Mean products of easy ($M = 2426$) and hard problems ($M = 2408$) were comparable when solved with either rounding-down or rounding-up strategy. To avoid the use of other well-known mental arithmetic strategies that may facilitate estimation, easy and hard problems excluded the use of zero and five as unit digits, and the repetition of digits within (e.g., 33×62) or across (e.g., 32×36) the operands. The order of the problem presentation was also controlled such that (a) the larger operand was presented first (e.g., 67×34) in half the problems and second in the

other problems (e.g., 43 x 72), (b) reversed operand orders were never used (e.g., 56 x 23 vs. 23 x 56), and (c) the smallest unit was presented first in half the problems (e.g., 62 x 37) and second in the other problems (e.g., 48 x 32).

Procedure

Before the experiment starts in earnest, participants took the arithmetic fluency task and the MMSE (for older adults) and were asked how many years of education they achieved. In one session of 60 minutes, participants under stereotype threat or control conditions completed the computational estimation task (e.g., 32 x 67). Participants under stereotype threat and control conditions received different instructions (see *Supplementary Material*). These instructions were adopted from previous studies (Lemaire et al., 2018; Mazerolle et al., 2012; Nicolas et al., 2020), and were used here as they proved effective in manipulating stereotype threat in these past studies.

Participants solved all each problem twice, and problems were presented on a laptop in a standardized horizontal arithmetic format « *Operand 1 x Operand 2* ». Participants were first tested in a choice condition (to investigate arithmetic strategy choices), and second in a no-choice condition (to investigate arithmetic strategy execution), with a brief period of 5-10 minutes between the two conditions. Such a Choice/No-choice procedure (Siegler & Lemaire, 1997) has been used in many studies across many cognitive domains, as it enables to investigate age-based stereotype threat effects on arithmetic strategy execution, uncontaminated by strategy use. In the choice condition, participants were free to select arithmetic strategies (i.e., rounding-down or rounding-up) to obtain the best estimate (i.e., closest to the correct response) on each problem.

Rounding down consists in rounding both operands down to their closest decades (e.g., doing 40x60 to estimate 43 x 68) and rounding up consists in rounding both operands up to their closest decades (e.g., doing 50x60). In the no-choice condition, the strategy to be

executed was cued for each estimation problem. The cued strategy was either a better strategy (one that yielded an estimate closest to the correct response) or a poorer strategy. Participants calculated out loud in each condition, and the experimenter recorded the estimate and the strategy used on each trial. The problem display, response recording, and latency data with 1-ms accuracy were controlled by E-prime software. Problems remained on the screen until participants responded. Two example problems in choice and no-choice conditions were explained at the beginning of the session. Participants received no monetary (or other) compensations for their participation.

Analytic Plan

Data were analyzed to compare effects of age-based stereotype threat in Indian and French participants, first on performance then on better strategy choices. Following previous works using the choice/no-choice method proposed by Siegler and Lemaire (1997), performance was analyzed in the choice condition and no-choice conditions separately. Performance measures include solution latencies and accuracy or quality of estimates as measured by percent deviations between correct products and estimates. Performance in the choice and no-choice conditions are not directly compared because they differ on whether participants choose strategies on each problem in choice condition and do not select strategies in no-choice condition. Choice and no-choice conditions also differ in the number of times each strategy is used, how often the better strategy is used, and on which problems each strategy is used. Thus, choice performance enabled us to compare effects of age-based stereotype threat when participants select and execute strategies whereas no-choice performance enabled us to examine effects of age-based stereotype when strategy selection is controlled.

In the choice condition, mean solution latencies and percent deviations were analyzed with 2 (Group: French, Indian) x 2 (Condition: threat control) x 2 (Problems: easy, hard)

mixed-design ANOVAs, with group and condition as between-participants factors. In the no-choice condition, latencies and percent deviations were analyzed with 2 (Group: French, Indian) x 2 (Condition: threat control) x 2 (Problems: easy, hard) x 2 (Trial: poorer-strategy, better-strategy) mixed design, with group and condition as between-participants factors. Then, mean percentages of use of the better strategy in the choice condition were analyzed with a 2 (Group: French, Indian) x 2 (Condition: threat control) x 2 (Problems: easy, hard) mixed design ANOVA, with group and condition as between-participants factors (see detailed results in Supplementary Tables S1-S2 and Supplementary Figure S1).

Results

Performance in the Choice Condition

The 2 (Group: French, Indian) x 2 (Condition: threat control) x 2 (Problems: easy, hard) mixed-design ANOVAs first indicated a significant main effect of Group on solution latencies ($F(1,100) = 56.25$, $MSe = 75283718.66$, $p < .001$, $\eta^2_p = 0.36$) and percent deviations ($F(1,100) = 18.99$, $MSe = 249.86$, $p < .001$, $\eta^2_p = 0.16$). As can be seen in Table 3, Indian participants were 1702 ms faster and deviated 3.1% less than French participants. This group difference on mean latencies was qualified by a significant Group x Problem interaction ($F(1,100) = 3.99$, $MSe = 1024667.31$, $p = .048$, $\eta^2_p = .04$), indicating that Indian participants were less slowed by hard problems (hard-easy = 378 ms, $F(1,100) = 14.50$, $p < .001$, $\eta^2_p = 0.13$) than were French participants (hard-easy = 659 ms, $F(1,100) = 44.04$, $p < .001$, $\eta^2_p = 0.31$).

Most interestingly, the Group x Condition interaction was significant on percent deviations, $F(1,100) = 6.21$, $MSe = 81.74$, $p = .014$, $\eta^2_p = .058$, and marginally significant on latencies, $F(1,100) = 3.66$, $MSe = 4900511.54$, $p = .059$, $\eta^2_p = 0.04$. Breakdown analysis in each French and Indian groups revealed that, relative to the control condition, stereotype threat led French participants to be 3.6% farther from correct estimates ($F(1,100) = 12.71$, $p =$

0.001, $\eta^2_p = 0.11$), whereas Indian participants did not differ in percent deviations across conditions ($F < 1.0$, $p = 0.968$). These effects were qualified by a Group x Condition x Problem interaction that was significant on latencies, $F(1,100) = 13.91$, $MSe = 3565035.39$, $p < .001$, $\eta^2_p = .122$, and marginally significant on percent deviations, $F(1,100) = 3.09$, $p = .082$, $MSe = 49.63$, $\eta^2_p = .03$. Contrast analyses on latencies revealed that stereotype threat effects among French participants occurred on easy problems ($F(1,100) = 19.76$, $p < 0.001$, $\eta^2_p = 0.165$), but not on harder problems ($F(1,100) = 2.71$, $p = 0.103$, $\eta^2_p = 0.026$). No other contrasts reached significance.

Insert Table 3 About Here

Performance in the No-Choice Condition

The 2 (Group: French, Indian) x 2 (Condition: threat control) x 2 (Problems: easy, hard) x 2 (Trial: poorer-strategy, better-strategy) mixed ANOVAs indicated a significant main effect of Group on both solution latencies ($F(1,100) = 99.54$, $MSe = 97794923.80$, $p < .001$, $\eta^2_p = 0.50$) and percent deviations ($F(1,100) = 25.10$, $MSe = 26.09$, $p < .001$, $\eta^2_p = 0.20$). Indian participants were 1939 ms faster and 1% more accurate than French participants. The main effect of Trial was also significant ($F(1,100) = 140.90$, $MSe = 23095491.30$, $p < .001$, $\eta^2_p = 0.58$) and indicated that all participants were slower with the poorer strategy (4432 ms) than with the better strategy (3961 ms). Most interestingly, the Group x Condition x Trial interaction was significant on mean latencies, $F(1,100) = 42.56$, $MSe = 6976683.00$, $p < .001$, $\eta^2_p = 0.30$ (see Table 4 for all the means). Contrasts revealed significant effects of threat in French participants on poorer-strategy trials (threat – control = 1070 ms; $F(1,100) = 14.15$, $p < .001$, $MSe = 14903501.60$, $\eta^2_p = 0.12$) and nonsignificant effects of threat on better-strategy trials ($F < 1.0$, $p = .812$), whereas no significant effects of threat were found in Indian

participants on either poorer-strategy trials or better-strategy trials ($F_s < 1.0, p > .800$). In other words, French participants were slower in the threat condition than in the control condition on the most difficult, poorer-strategy trials but equally fast in the threat and control conditions on the easiest, better-strategy trials. Indian participants had comparable performance in the threat and control conditions on both better-strategy trials and poorer-strategy trials.

When analyzed in terms of percent deviations, the significant Group x Condition interaction ($F(1,100) = 4.44, MSe = 4.61, p = .038, \eta^2_p = 0.04$) showed that cultural differences were larger in the threat condition (French – Indian = 1.4%; $F(1,100) = 25.32, p < 0.001, \eta^2_p = 0.20$) than in the control condition (French – Indian = 0.6%; $F(1,100) = 4.22, p = 0.043, \eta^2_p = 0.04$). Additionally, whereas there was a nonsignificant trend of age-based stereotype threat to affect strategy execution in French older adults (threat-control = 0.5%; $F(1,100) = 3.38, p = 0.069, \eta^2_p = 0.03$), it was clearly not significant in Indian older adults (threat-control = -0.3%; $F(1,100) = 1.29, p = 0.257, \eta^2_p = 0.01$).

Insert Table 4 About Here

Use of the Better Strategy in the Choice Condition

The 2 (Group: French, Indian) x 2 (Condition: threat control) x 2 (Problems: easy, hard) mixed design ANOVA revealed a significant main effect of Group ($F(1,100) = 38.26, MSe = 2819.81, p < .001, \eta^2_p = .28$) and Condition ($F(1,100) = 43.32, MSe = 3192.31, p < .001, \eta^2_p = .30$): Indian participants selected the better strategy (84.24%) more often than the French participants (73.83), and all participants selected the better strategy more often in the control (84.57%) than in the threat condition (73.49%). The Group x Condition interaction ($F(1,100) = 18.76, MSe = 1382.59, p < .001, \eta^2_p = .16$) indicated that this effect of stereotype

threat was significant in French participants ($F(1,100) = 59.55, MSe = 4388.32, p < .001, \eta^2_p = .37$) but not in Indian Participants ($F(1,100) = 2.53, MSe = 186.58, p = .115, \eta^2_p = .03$).

Most interestingly, the Group x Condition x Problem interaction came out significant, $F(1,100) = 18.35, MSe = 998.95, p < .001, \eta^2_p = 0.16$ (Figure 1). Contrast analyses revealed decreased percent use of the better strategy on both easy ($F(1,100) = 74.75, p < 0.001, \eta^2_p = 0.43$) and hard problems ($F(1,100) = 22.93, p < 0.001, \eta^2_p = 0.19$) in French participants but only on hard problems in Indian participants ($F(1,100) = 7.89, p = 0.006, \eta^2_p = 0.07$). Further comparison of stereotype threat effects in strategy selection across cultures revealed significant group differences on easy problems (Indian – French = 24%, $F(1,100) = 82.89, p < 0.001, \eta^2_p = 0.45$) and comparable strategy selection in the control condition (Indian – French = 0.5%, $F < 1.0, p = 0.846$). On hard problems, cultural differences were twice as large in the threat condition (Indian – French = 12%, $F(1,100) = 15.41, p < .001, \eta^2_p = 0.13$) than in the control condition (Indian – French = 6%, $F(1,100) = 3.79, p = 0.054, \eta^2_p = 0.04$). No other effects came out significant in either participants' strategy selection or performance under the choice or no-choice condition.

Insert Figure 1 About here

Finally, to examine whether the above findings hold whatever individual differences in basic arithmetic fluency, we ran the same mixed-design ANOVAs with participants' arithmetic fluency test scores and the interaction Condition x Arithmetic Fluency as covariates (Yzerbyt, Muller, & Judd, 2004). We found the same results. Also, the same results were obtained when analyses were run on a selected sub-sample of 15 participants in each condition, matched on basic arithmetic skills (i.e., in threat condition, mean arithmetic fluency

scores, $M_{French} = 83$, $M_{Indian} = 81$, $p = 0.746$; in control condition, $M_{French} = 85$, $M_{Indian} = 82$, $p = 0.727$).

Discussion

Our findings document cultural variability in stereotype threat effects in older adults. Consistent with previous studies among older adults from Western culture (Lamont et al., 2015; Barber, 2017), French participants' arithmetic performance deteriorated under stereotype threat. In contrast, age-based stereotype threat did not affect Indian participants' arithmetic performance. Examination of arithmetic strategies showed that French participants used and executed strategies on each problem less efficiently under threat condition than under control condition. Unlike French participants, age-based stereotype threat impaired strategy selection of Indian participants only on harder arithmetic problems and much less on these problems than French participants.

Our results complement Tan and Barber (2020)'s findings to inform how culture modulates age-based stereotype threat effects. Tan and Barber found effects of stereotype threat in Chinese older adults living in the US, although these Chinese participants grew up in China, suggesting that age-based stereotype threat effects are found across different cultures. Also, Tan and Barber (2020) found no age-based stereotype threat effects in a group of Chinese participants who were reminded Confucian values of filial piety, suggesting that stereotype threat effects can vary with cultural contexts, as was directly found in our study. Altogether, the present findings and Tan and Barber's findings have important implications to further understand interactions among culture and effects of stereotype threat.

First, these findings suggest that modulations of age-based stereotype threat effects by cultural values maybe context dependent. It is possible that magnitude of these effects was modulated by cultural values in both our Indian participants and in Tan and Barber's Chinese participants who were reminded Confucian values as a result of the context in which they

were tested. This experimental context led participants to approach the task with a more positive mindset towards older adults. As a consequence, negative consequences of age-based stereotypes had much smaller effects on older adults' memory performance (in Tan and Barber's study) and arithmetic performance and strategy selection (in our study). Another important implication is that, when we investigate stereotype threat effects in groups of different cultures, it may be important to distinguish between the culture in which participants were raised and the culture they currently live in. Stereotype threat effects may be different in participants who grew up in one culture but live in a different versus the same culture.

Our findings uniquely establish cultural differences in how stereotype threat affects French and Indian older adults' performance. Note that group differences in baseline arithmetic proficiency did not account for group differences in stereotype threat effects. This is consistent with the assumption made by Steele and Aronson (1995) that stereotype threat is a situational factor that greatly influences participants' performance; these effects also vary with culture.

Cultural differences in how stereotype threat impairs older adults' cognitive performance suggest that age-based stereotype threat is likely a culture-based risk factor that may predict cultural differences in cognitive aging. Although several factors (e.g., social orientation, education, cognitive approach, urbanization) have been investigated as key determiners of cultural differences in cognition (Na et al., 2017; Nisbett & Miyamoto, 2005; Parmar et al., 2004; Varnum et al., 2010), the cultural differences in effects of stereotype threat found here have implications for understanding the interactions between culture, aging, and cognition. We found that cultural differences in arithmetic performance were inflated on harder problems, under threat condition. Moreover, on easier problems where French and Indian participants had comparable performance in the control condition, cultural differences emerged in the threat condition. Thus, cross-cultural differences in older adults' performance

may stem partly from (or may be much enhanced by) age-related stereotypes prevalent in cultures. Future studies can also investigate “attitudes towards aging” as a plausible factor for differential effects in age-based stereotype threat. There is some evidence that attitudes towards aging and memory performance are positively correlated (Levy & Langer, 1994), and that individuals with positive self-perceptions of aging, relative to those with negative self-perceptions of aging, demonstrate faster health recovery (Levy, Slade, May, & Caracciolo, 2006; Levy, Slade, & Kasl, 2002). Also, results from our pilot study indicate that Indian older adults hold fewer negative attitudes towards aging than French older adults. The main study further found Indian older adults to be less susceptible to age-based stereotype threat effects. A limitation of our study was that stereotype threat effects and attitudes towards aging were not measured in the same individuals. Thus, future studies could directly test the moderating role of automatic associations towards aging in age-based stereotypes threat effects. This could be done by observing individual differences in aging attitudes and determining whether older adults who are most likely to show performance impairment under stereotype threat are those with more negative attitudes towards aging.

Our results offer a new explanation to cultural differences in cognitive aging through a social lens. While many of the determiners of cognitive aging are reliant on and intertwined with physiological and genetic factors that are not modifiable, age-related stereotypes is a modifiable risk factor (Dixon & Lachman, 2018). Thus, cognitive decline due to such culturally-variant situational factor can be easily curbed by educating populations about ageism (Crawford, 2015). Such instructional interventions have previously led female participants to inoculate gender stereotype effects on math tests (Johns et al., 2005). Likewise, the bias habit breaking model, which has proved successful to reduce race and gender biases (Forscher et al., 2017), could be fruitfully extended to aging to help older adults use their full cognitive abilities unconstrained by negative aging stereotypes.

To conclude, our findings show the universality yet diversity in the experience of age-based stereotype threat effects. We did this by contrasting stereotype threat effects often found in older adults from India and from France. The present empirical study was run in arithmetic. It would be important to generalize these finding to other cognitive domains (like memory) for which a number of previous studies have robustly documented effects of age-based stereotype threat. Moreover, theoretical advances in cultural cognition and most importantly the impact of aging stereotypes on cognition demands broad regional coverage (i.e., investigations among other non-Western participants). For example, data from regions such as the Arab Middle East, Sub-Saharan Africa, South America may yield dimensions different from those identified here, and in the Western context.

Author Contributions

P.N., I.R., and P.L. designed research. PN collected data and ran statistical analyses. PL and IR devised the set of arithmetic stimuli and the procedure for the age-based stereotype threat manipulations, respectively. PN, IR, and PL wrote the paper.

Conflict of Interest

All authors declare no conflict of interest.

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Correspondence about this paper should be directed to Patrick Lemaire, Aix-Marseille University & CNRS, 3 Place Victor Hugo, Case D, 13331 Marseille, France (email: Patrick.Lemaire@univ-amu.fr). Data, analytic methods, and study materials will be made available to other researchers on COS, once the paper is accepted for publication. This study was not preregistered.

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Table 1*Participants' Characteristics in the IAT Study*

Variables	French Participants	Indian Participants	<i>p</i>
<i>N</i> (Females)	53 (31)	53 (32)	--
Age (<i>Mean; Range</i>)	66 (51—83)	68 (50—85)	.12
IAT RTs (in ms)	1273	1116	.01
IAT Accuracy (in %)	93	94	.28

Table 2*Participants' Characteristics in the Age-Based Stereotype Threat Experiment*

Variables	French			Indian		
	Threat <i>M(SD)</i>	Control <i>M(SD)</i>	<i>p</i>	Threat <i>M(SD)</i>	Control <i>M(SD)</i>	<i>p</i>
<i>N</i> (Females)	26 (18)	26 (17)	--	26 (13)	26 (16)	--
Age (in Years)	72.1 (5.7)	72.7 (5.4)	0.69	70.8 (4.4)	71.6 (3.7)	0.59
Education (in Years)	13.0 (2.6)	12.1 (1.7)	0.14	13.7 (1.9)	13.6 (1.8)	0.79
MMSE	29.3 (0.9)	28.9 (0.9)	0.16	29.5 (0.8)	29.2 (0.9)	0.27
Arithmetic Fluency	71.5 (17.1)	73.1 (21.1)	0.79	94 (27.8)	92.2 (19.6)	0.78

Table 3

French and Indian Participants' Mean Solution Latencies (in ms), and Absolute Percent Deviations (in parentheses) on Easy and Hard Problems in the Choice Condition for Participants Tested under Threat or Control Conditions

Problems	French				Indian			
	Threat	Control	Means	Differences	Threat	Control	Means	Differences
Easy	4114	5514	4814	1400*	3248	3256	3252	8
	(8.3)	(1.5)	(4.9)	(-6.8)*	(2.2)	(0.9)	(1.5)	(-1.3)
Hard	5180	5765	5472	585	3510	3751	3630	241
	(8.1)	(7.6)	(7.8)	(-0.5)	(4.4)	(5.5)	(4.9)	(1.1)
Means	4647	5639	5143	992*	3379	3503	3441	124
	(8.2)	(4.5)	(6.3)	(-3.7)*	(3.3)	(3.2)	(3.2)	(-0.1)

Note. Differences = Control – Threat.

* $p < .01$.

Table 4

French and Indian Participants' Mean Solution Latencies (in ms) and Absolute Percent Deviations (in parentheses) on Easy and on Hard Problems in the No-Choice Condition when Executing a Poorer or a Better Strategy under the Threat or Control Conditions

Problems	Threat			Control		
	Poorer Strategy	Better Strategy	Differences	Poorer Strategy	Better Strategy	Differences
French Participants						
Easy	6066 (1.6)	4749 (2.1)	1317 (-0.5)	5062 (1.1)	4743 (1.1)	319 (0.0)
Hard	6102 (0.9)	4884 (1.7)	1218 (-0.8)	4965 (1.2)	4759 (0.9)	206 (0.3)
Means	6086 (1.2)	4816 (1.9)	1270 (-0.7)	5013 (1.1)	4751 (1.0)	262 (0.1)
Indian Participants						
Easy	3251 (0.4)	3017 (0.1)	234 (0.3)	3302 (0.9)	3106 (0.1)	196 (0.8)
Hard	3312 (0.1)	3222 (0.1)	90 (0.0)	3397 (0.6)	3207 (0.3)	190 (0.3)
Means	3282 (0.2)	3120 (0.1)	162 (0.1)	3350 (0.7)	3157 (0.2)	193 (0.5)

Note. Differences = Poorer – Better

Figure 1

French and Indian Participants' Mean Percentages of Use of the Better Strategy on Easy and Hard Problems in Threat and Control conditions.

Note. Error Bars represent 95% confidence intervals.