Learning and Individual Differences 42 (2015) 77–82

Contents lists available at ScienceDirect

Learning and Individual Differences

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

Map learning in young and older adults: The influence of perceived stereotype threat

Chiara Meneghetti [a,*], Veronica Muffato [a], Caterina Suitner [b], Rossana De Beni [a], Erika Borella [a,*]

[a] Department of General Psychology, University of Padova, Italy
[b] Department of Developmental Psychology and Socialisation, University of Padova, Italy

ARTICLE INFO

Article history:
Received 1 September 2014
Received in revised form 22 April 2015
Accepted 15 August 2015

Keywords:
Perceived stereotype threat
Map learning
Age differences

ABSTRACT

This study aimed to analyze whether social factors such as perceived stereotype threat can influence spatial recall in aging. Thirty-four young, 34 young-old and 34 old-old adults studied a map and then performed spatial recall tasks (pointing, a verification task and map drawing) and completed a questionnaire measuring their perceived stereotype threat concerning spatial skills declining with age. Results showed a worse spatial recall performance in both the older groups (young-old and old-old) than in the young adult group. In the map-drawing task, the age effect was also mediated by the perceived stereotype threat. Overall, these findings indicate that perceived stereotype threat mediates the relationship between age and map learning, depending on the type of spatial recall task used.

1. Introduction

Being able to reach a destination is essential to daily functioning and independent living. To acquire environment knowledge people form mental maps (as conceptualized by Tolman, 1948), which are assumed to mentally represent the environment (e.g., Wolbers & Hegarty, 2010). Using maps that depict a given area, showing landmarks and how they are located in relation to one another, facilitates the construction of a spatial mental representation with configurational features (e.g., Richardson, Montello, & Hegarty, 1999; Thorndyke & Hayes-Roth, 1982).

Older adults may need to use maps as a source of information (for instance, they may consult a map to see how to reach their doctor's new office) in order to remain self-sufficient in their interaction with their environment (e.g., Burns, 1999). Cognitive researchers have studied how map learning skills change with aging, finding a worse map learning performance in older than in younger adults (Borella, Meneghetti, Muffato, & De Beni, 2014; Klencklen, Després, & Dufour, 2012; Wilkniss, Jones, Korol, Gold, & Manning, 1997). This is generally attributed to an age-related decline in cognitive abilities (Craik & Salthouse, 2008), such as spatial skills (Meneghetti, Fiore, Borella, & De Beni, 2011). Importantly, results emerging within this frame of reference suggest that older adults' declining map recall performance may relate to the type of task involved. Three recall tasks frequently used to assess age-related differences in map learning involve: (i) graphically reproducing a map of an environment (map-drawing tasks, e.g., Coluccia, Bosco, & Brandimonte, 2007; Wilkniss et al., 1997); (ii) imagining standing in a given place (or landmark) on a map while facing another and pointing towards a third (pointing tasks, Richardson et al., 1999; or judgments of relative direction, Shelton & McNamara, 2001); and (iii) answering questions that entail judging spatial relations between landmarks (verification tests, e.g., Meneghetti, Borella, Grasso, & De Beni, 2011; Taylor & Tversky, 1992). Studies on age-related differences have consistently shown that older adults perform less well than younger adults in pointing tasks (Borella et al., 2014; Meneghetti, Borella, Gyselinck, & De Beni, 2012), and verification tasks (Meneghetti et al., 2012). When map-drawing tasks were used, however, while some studies found a worse performance in older adults (Borella et al., 2014; Meneghetti, Fiore, et al., 2011), others showed a similar performance between older and young adults (Meneghetti et al., 2012; Meneghetti, Borella, et al., 2011; Yamamoto & DeGirolamo, 2012). These discrepancies can be attributed to several differences in the procedures used. For instance, providing a list of landmarks (Yamamoto & DeGirolamo, 2012) or asking people to reproduce a regular environment (Meneghetti, Borella, et al., 2011) reduces age-related differences by comparison with when no list of landmarks is provided (Borella et al., 2014), or the environment is irregular (Meneghetti, Fiore, et al., 2011). The lack of age-related differences could also be attributed to the combination of the type of request involved in the recall task and the type of input to be learnt. Indeed, studying a map and then drawing it from memory is a task that preserves the same (visuo-spatial) format and perspective (bird's eye view), whereas other tasks require a change of format (i.e., from a visuo-spatial to a verbal format in verification tests) or perspective (i.e., from an aerial to the observer's view in pointing tasks). Taken together, these studies thus suggest that the age-related decline seen in environment learning skills depends on the type of task used

* Corresponding authors at: Department of General Psychology, University of Padova, Via Venezia, 8, 35131 Padova, Italy.
E-mail addresses: chiara.meneghetti@unipd.it (C. Meneghetti), erika.borella@unipd.it (E. Borella).

http://dx.doi.org/10.1016/j.lindif.2015.08.015
1041-6080/

to measure recall; indeed, the age-related differences appear more evident in some tasks (e.g., pointing and verification tests) than in tasks that more closely resemble the learning modality (e.g., map drawing). The reason for this difference is still unclear, given that all these tasks are sustained by the same cognitive abilities. In fact, research has demonstrated, in both young and older adults, that spatial recall tasks (pointing and map drawing) after learning a map require the use of fluid abilities (Meneghetti, Borella, et al., 2011), working memory (Borella et al., 2014) and spatial abilities (e.g., Meneghetti, Borella, et al., 2011).

The social-cognitive domain offers a different theoretical approach to the question of older people's environment learning. Age-related differences in environment learning may be modulated not only by cognitive factors, but also by social factors such as stereotypes. The literature on aging clearly shows that older adults have more negative beliefs about aging and memory than younger people, and that these convictions negatively impact their memory performance and allocation of processing resources (Chasteen, 2000; Chasteen, Bhattacharyya, Horhota, Tam, & Hasher, 2005; Hertzog & Hultsch, 2000; Horton, Baker, Pearce, & Deakin, 2008). Studies on stereotype threat have shown that individuals' cognitive performance can be undermined by the activation of negative stereotypes concerning the group to which they belong, especially if their group is important to them (Steele, 1997; Steele & Aronson, 1995). For instance, older adults may feel threatened by any mention of the stereotype that memory declines with aging, and this makes them perform less well in memory tasks than other older adults who are not reminded about this stereotype (e.g., Hess, Auman, Colcombe, & Rahhal, 2003).

The effect of the aging stereotype on performance was evident not only when stereotypes were activated by manipulating the threat but also when the threat was perceived by participants due to their own beliefs about aging stereotypes (Chasteen et al., 2005; Kang & Chasteen, 2009). In this latter case, the source of the threat is the self (Shapiro & Neuberg, 2007). In Chasteen et al. (2005), for instance, young and older participants were given information about a target person and set a task presented as a test either of their memory or of how they formed their impressions; perceived stereotype threat of participants was also assessed. The results showed that older adults reported a stronger perception of stereotype threat and had a worse recall performance than young adults, and that the effect of age on recall performance was mediated not by the type of instruction, but by the perceived stereotype threat. This goes to show that older adults' memory performance is influenced by their social context, confirming the important influence of perceived stereotype threat on their recall performance.

The effect of stereotype also seems to vary depending on the type of task used to test memory (recall) performance. Kang and Chasteen (2009), examined the impact of perceived stereotype threat in conditions with a stereotype threat (activated by manipulating instructions and setting) and without a stereotype threat, on older adults' performance in prose recall tasks. Concerning perceived stereotype threat, their results showed that: i) the state (situational) perceived stereotype threat affected memory for the prose passage tested by cued recall (when participants answered open-ended questions); and ii) the trait (dispositional) perceived stereotype threat affected free recall (when participants were asked to report everything they could remember). In contrast, the perceived (state or trait) stereotype threat did not impair performance when a recognition task was used (that involved choosing from a list of options the name of the speaker of quotations drawn from the passage). Only performance in the cued recall task interacted with perceived (state and trait) stereotype threat and the manipulation threat's effect, however; in fact, when stereotype was activated by manipulating the threat, the decrease in cued recall performance was associated with an high perceived stereotype threat. The authors concluded that the perceived stereotype threat only moderated the stereotype threat's effect on memory performance in some tasks (such as recalling information in response to a cue); on the other hand, perceived stereotype threat did not influence the manipulation threat's effect on recognition or free recall tasks that the authors considered “easy” and “difficult”, respectively. These results suggest that different task features and requests contribute to modulating the influence of perceived stereotype threat on final recall task performance and indicate that perceived stereotype threat can be considered a core factor capable of mediating the relationship between age and memory performance.

So far, however, the literature on aging and stereotype has mainly explored this effect on memory tasks involving verbal features, such as prose passages (e.g., Kang & Chasteen, 2009), or word lists (e.g., Hess et al., 2003), while no evidence comes from memory tasks involving spatial features, as in the case of map learning. Such social aspects of memory as perceived stereotype threat may prompt an inadequate allocation of cognitive and spatial processing resources by influencing motivation and effort, and this would contribute to older adults' poor performance in the spatial domain too.

The aim of the present study was thus to examine to what extent age-related differences between young and older adults performing spatial memory tasks (focusing on map learning) are influenced by negative stereotypes about aging and spatial skills. We thus mainly examined: (a) whether aging stereotypes mediate the relationship between age and spatial memory tasks referred to map learning; and (b) whether this relationship can change as a function of the type of task used to measure map recall (as suggested by Kang & Chasteen, 2009).

To elucidate these issues, a sample of young, young-old and old-old participants was asked to study a map; their recall was tested using pointing, verification and map-drawing tasks; their perceived stereotype threat concerning age and spatial skills (i.e. their general perception) was also assessed. For this latter purpose, the Perceived Stereotype Threat scale was administered as the last step to avoid activating any stereotype that might negatively affect the participants' recall performance (this is normal procedure in perceived stereotype threat studies, e.g., Chasteen et al., 2005).

Older adults were divided into young-old and old-old to see whether their spatial learning decline became more accentuated with time, as suggested in the aging literature (e.g. Baltes, 1987). Few studies have compared the age-related decline in the young-old and old-old in the spatial cognition domain (Meneghetti, Borella, Muffato, Pazzaglia, & De Beni, 2014).

First, we examined age-related differences in the performance of spatial recall tasks. We expected young-old adults to perform worse than young adults in pointing and verification tasks (e.g., Meneghetti et al., 2012; Wilkniss et al., 1997); we also explored whether the young-old adults' map-drawing performance was worse (Borella et al., 2014), or comparable (Yamamoto & DeGirolamo, 2012) with that of the younger group. As for the older groups, we expected the old-old to show a more accentuated decline than the young-old (as suggested by Baltes, 1987) especially for tasks that are demanding in terms of cognitive resources, such as the pointing task, which involves managing spatial information (e.g., Borella et al., 2014).

Second, regarding the perceived stereotype threat, we examined whether the two groups of older adults differed in their susceptibility to perceived stereotype threat (as suggested by Hess, Hinson, & Hodges, 2009). On the relationship between perceived stereotype threat, age and spatial recall tasks (the main aim), we hypothesized that perceived stereotype threat can mediate the relationship between age and spatial recall performance as an extension of the negative impact of aging stereotype in older adults' recall in verbal tasks (Chasteen et al., 2005). Given that the impact of a perceived stereotype threat can also depend on the difficulty of the task (as suggested by Kang & Chasteen, 2009), we can expect the negative influence of stereotype threat on spatial memory tasks to vary as a function of the type of task performed (map drawing, verification test or pointing task), because of their different cognitive demand. Considering map learning in

aging, the verification test and pointing task can be classified as objectively difficult tasks. The verification test involves judging sentences on the truthfulness of the relationship between landmarks when moving from a visuospatial presentation format (the map learnt) to a verbal one. The pointing task preserves the same (visuospatial) format as the input learnt, but it involves having to imagine adopting positions and pointing in directions within a spatial layout, moving from an aerial view (map learning) to a within-layout view. The map-drawing task can be considered objectively easier than the previous two because it preserves the same spatial format and the same view as in the learning phase, enabling older adults to perform adequately (as previously suggested by Yamamoto & DeGirolamo, 2012; see also Meneghetti, Borella, et al., 2011). Map drawing can therefore be considered less demanding than verification and pointing tasks. We consequently examined the effect of perceived stereotype threat in relation to different types of spatial recall task in young, young-old and old-old, and assumed that map-drawing performance (because the task was less demanding) might be more susceptible to perceived stereotype threat in older adults.

2. Method

2.1. Participants

The study involved 102 native Italian-speaking volunteers: 34 young adults (17 females and 17 males, aged 20 to 30, *M* age = 24.03), 34 young-old adults (17 females and 17 males, aged 60 to 74, *M* age = 66.41) and 34 old-old (17 females, and 17 males, aged 75 to 84, *M* age = 78.65). All participants were volunteers and recruited by word of mouth. The young participants were workers or university students; the young-old and old-old adults attended recreation centers and were all retired, healthy, and living independently, and had Mini-Mental State scores (MMSE, Folstein, Folstein, & McHugh, 1975) of more than 27 (as required by our inclusion criteria). Performance on the Wechsler Adult Intelligence Scale — Revised (WAIS–R) vocabulary score (Wechsler, 1981) did not differ statistically between the three groups (z-scores, $p = .64$), and they all had adequate vocabulary scores (see Italian norms developed by Orsini & Laicardi, 2003). The groups differed in years of formal education, $F(2,99) = 16.71$, $\eta_p^2 = .25$, $p < .001$ (young adults had more schooling than older adults); both groups of older adults had nonetheless had at least 10 years of formal education and the difference vis-à-vis the younger group was due to the cohort effect (see ISTAT, 2011). See Table 1 for participants' demographic characteristics.

2.2. Materials

2.2.1. Maps

Two maps of a fictitious Zoo and Holiday farm were used (see Borella et al., 2014). Each map was arranged within a rectangle (180 × 200 mm) and included 10 landmarks indicated by their corresponding names and drawings (e.g., the park and ticket office at the zoo). The cardinal points (north, south, east, west) were indicated around the edges of the map.

2.2.2. Pointing task

Using a computerized version (E-Prime 2.0), two items were presented for familiarization purposes and 12 for the actual task. For each item (projected on the screen), participants were asked to imagine standing at one landmark and facing towards another, and to point in the direction of a third (e.g., Zoo: "Imagine being in the park and facing the ticket office. Point towards the dolphins"). In all items the map's orientation and the participant's view were misaligned by at least of 90° and participants answered by using the mouse to align an arrow shown in a circle in the middle of the screen with the landmark.

Table 1
Means (M) and standard errors (SE) of demographic variables of young, young-old and old-old participants.

	Young		Young-old		Old-old	
	M	SE	M	SE	M	SE
Age	24.03	0.45	66.41	0.70	78.65	0.47
Years of education	15.71	0.30	11.53	0.62	12.56	0.61
Vocabulary (z score)	−0.14	0.17	0.23	0.22	0.04	0.17

2.2.3. Verification test

Using a computerized version (E-Prime 2.0), two sentences were presented in a familiarization phase and 12 were used for the actual task. Each sentence appearing on the screen tested spatial relations between landmarks (e.g., Zoo: "The park is to the north-east of the gate") and participants answered by pressing one of two keys on the keyboard ('c' for true, 'm' for false).

2.2.4. Map-drawing task

This involved reproducing the layout of the map on a blank sheet of paper, placing the landmarks in the right positions.

2.2.5. Perceived Stereotype Threat scale (adapted from Steele & Aronson, 1995)

This scale comprises 5 items (Cronbach's $\alpha = .78$) assessing people's beliefs about stereotypes linking age with spatial skills (e.g., "Based on my age, people often underestimate my spatial skills"). Answers are given on a 7-point scale ranging from 1 ("I strongly disagree") to 7 ("I strongly agree").

2.3. Procedure

Participants were tested individually during a single, one-hour session in a quiet room. First they completed a socio-demographic questionnaire, the MMSE, and the vocabulary test, and they became familiar with the laptop (17″). Then they were instructed to study a map (Holiday farm or Zoo, presented in a balanced order) for up to 5 min before performing a series of tasks. After the study phase, participants performed the pointing task, the verification test and the map-drawing task. The sentences in the pointing task and verification test were presented in random order. In the last step, they completed the Perceived Stereotype Threat scale.

3. Results

3.1. Scoring

For the pointing task, the mean values were computed by applying the circular statistics procedure (as proposed by Batschelet, 1981) to the minimum absolute angles of difference (expressed in degrees of error) between the direction of the participant's answer and the right direction. For the verification test, each correct answer was awarded one point. For the map-drawing task, one point was awarded when the position where a landmark was drawn/written reflected its actual position on the map (the correlation between the score of two independent judges was $r = .95$ $p < .001$ and the analyses were run on the first judge's scores).

For the Perceived Stereotype Threat scale, the sum of the scores from 1 to 7 was considered (minimum: 5, maximum: 35; higher scores corresponding to a stronger perceived stereotype threat).

3.2. Age differences in recall task performance

Univariate ANOVA showed the main effect of Age on mean pointing, $F(2, 99) = 43.67$, $\eta^2 = .47$, $p < .001$, verification test, $F(2, 99) = 20.68$, $\eta^2 = .30$, $p < .001$, map drawing, $F(2, 99) = 19.43$, $\eta^2 = .28$, $p < .001$, and Perceived Stereotype Threat, $F(2, 99) = 13.16$, $\eta^2 = .21$, $p < .001$ (see Table 2). In all measures, the young, young-old and old-old adults

differed ($p < .001$), with a worse performance and stronger perception of stereotype threat in the older groups; the young-old and old-old did not differ in the map-drawing task or verification test ($p_s = 1.00$), or for perceived stereotype threat ($p = .58$), whereas the old-old made more mistakes ($p = .005$) than the young-old in the pointing tasks. Both the older adults groups had a similarly moderate score on the Perceived Stereotype Threat scale (young-old: $M = 15.97$, $SD = 0.93$; old-old: $M = 14.29$, $SD = 1.07$), while the young adult participants had lower scores ($M = 9.65$, $SD = 0.68$).

3.3. Relationship between age, perceived stereotype threat and spatial recall task performance

3.3.1. Correlations

The correlations between age, spatial recall tasks and perceived stereotype threat (see Table 3) showed moderate to large correlations between age and spatial task performance, older age being associated with a worse performance in map drawing, the verification test (accuracy), and the pointing task (higher degrees of error). Age also correlated positively with the Perceived Stereotype Threat score, which revealed a strong negative correlation with map-drawing performance, a moderate correlation with the verification test, and no significant correlation with pointing errors.

3.3.2. Mediation model analyses

Three models were computed using the LISREL 8.80 statistical package (Jöreskog & Sörbom, 1981), considering errors in the pointing task, and accuracy in the verification test and map-drawing task as dependent variables (one variable in each model). Based on our theoretical premises, age was considered as the initial predictor and perceived stereotype threat (total score) as a mediator between age and spatial task performance; spatial task performance was the dependent variable. Three models were run (one for each dependent variable) considering age, perceived stereotype threat and spatial recall performance (errors in the pointing task; accuracy in the verification test; accuracy in the map-drawing task) as continuous variables.

Verification test and pointing task. In the models considering pointing errors and verification test accuracy as dependent variables, the direct relationships between age and perceived stereotype threat, and between age and task performance (see β, z and p values in Table 4) proved significant, while the direct relationship between perceived stereotype threat and spatial tasks, and the indirect relationship between age and spatial tasks (by stereotype) did not (see Table 4). The total variance accounting for performance in the pointing task and verification test was 47% and 31%, respectively (explained by the significant direct relationship between age and task performance).

Map drawing. In the model considering map-drawing accuracy as the dependent variable, we found significant direct relationships between: (i) age and perceived stereotype threat; (ii) age and map-drawing accuracy; and (iii) perceived stereotype threat and map-drawing accuracy (see Table 4 and Fig. 1 for the corresponding β and p values). Significant indirect relationships emerged between age and map drawing accuracy ($\beta = -0.09$, $z = -2.12$, $p = .03$), i.e. age negatively influenced map-drawing accuracy through the mediation of perceived stereotype threat. The total variance accounting for map-drawing performance was 32% (explained by the significant direct and indirect relationships between age and map-drawing accuracy, and by the direct relationship between perceived stereotype threat and map-drawing accuracy).

In all three models the total variance accounting for the perceived stereotype threat was 17% (explained by the significant relationship with age). A multigroup analysis was run to check for the effect of gender (given its role in spatial learning, Linn & Petersen, 1985): the parameters remained the same in the male and female groups ($\chi^2_{(3)} = 4.20$, $p = .24$).

Table 3
Correlations between age, spatial recall tasks and Perceived Stereotype Threat scores.

	1	2	3	4
1. Age	–			
2. Pointing errors	.68**	–		
3. Verification test accuracy	−.55**	−.63**	–	
4. Map drawing accuracy	−.53**	−.53**	.64**	–
5. Perceived Stereotype Threat scale	.41**	.19*	−.27**	−.40**

Note. N = 102.
* $p < .05$.
** $p < .01$.

4. Discussion of the results and conclusions

This study aimed to investigate how the perceived stereotype threat influences spatial memory (based on map learning) in young, young-old and old-old adults. Cognitive studies have shown that older adults (and especially the old-old, when they were considered separately) perform less well than young adults in spatial recall tasks after learning an environment (Borella et al., 2014; Klencklen et al., 2012) — although the results also depend on the spatial recall task administered. The social-cognitive domain offers a new theoretical framework for considering the role of stereotype threat in research on spatial recall decline with aging. Studies have already shown that the activation of aging and memory stereotypes negatively affects older adults' performance in verbal tasks (Hertzog & Hultsch, 2000; Horton et al., 2008), but no such studies have investigated the link between stereotype and spatial recall in older adults. This is of particular interest because older adults need to manage spatial materials such as maps to orient themselves in everyday life.

In the present study, we newly examined whether perceived stereotype threat could: (i) mediate age-related differences (distinguishing between young, young-old and old-old adults) in spatial recall performance; and (ii) have a different impact depending on the type of recall task considered.

First, we found that older adults (the young-old and old-old to much the same extent) performed worse than young adults in all spatial recall tasks, confirming the age-related decline in map learning skills (e.g., Wilkniss et al., 1997). It is worth mentioning that the worse performance found in older adults in map drawing too (as in Borella et al., 2014) could be attributable to the type of task, in which no list of landmarks was provided. Another finding was that the old-old only performed worse than the young-old in the pointing task (as shown by

Table 2
Means (M) and standard errors (SE) of spatial recall tasks (performed after map learning) and perceived stereotype threat scores by age group.

		Young		Young-old		Old-old		
		M	SE	M	SE	M	SE	
Spatial recall tasks	Pointing (errors)	32.30	5.15	67.93	4.69	87.29	2.22	Young > (Young-old > Old-old)
	Verification test (accuracy -12-)	10.79	0.29	8.12	0.48	7.62	0.33	Young > (Young-old = Old-old)
	Map drawing (accuracy -10-)	9.41	0.19	6.79	0.45	6.35	0.43	Young > (Young-old = Old-old)
Perceived Stereotype Threat		9.65	0.68	15.97	0.93	14.29	1.07	Young > (Young-old = Old-old)

Note: ">" means a difference that is significant (with $p < .01$ at least) and "=" means a difference that is not.

Table 4
Path model: Direct and indirect effects in the three models. Significant relationships in bold type.

		Pointing errors			Verification accuracy			Map accuracy		
Effects		β	*z*	*p*	β	*z*	*p*	β	*z*	*p*
Direct	Age → Y	**.73**	**9.14**	**<.001**	**−0.53**	**−5.78**	**<.001**	**−.44**	**−4.92**	**<.001**
	Age → M	**.41**	**4.48**	**<.001**	**0.41**	**4.48**	**<.001**	**.41**	**4.48**	**<.001**
	M → Y	−.11	−1.37	.17	−.06	−0.63	.53	**−.22**	**−2.41**	**.016**
Indirect	Age → M → Y	−.04	−1.31	.19	−.02	−0.62	.53	**−.09**	**−2.12**	**.034**

Note. Y = dependent variable; M = mediator = perceived stereotype threat.

Borella et al., 2014), i.e. in a task considered highly demanding because of the considerable cognitive resources involved (e.g. Meneghetti, Borella, et al., 2011).

Second, focusing on the role of stereotype, both of the older groups perceived significantly more stereotype threat than the young adults. The subjective perception of this threat did not affect our two older age groups to a different degree, whereas other studies found a stronger stereotype effect in the young-old than in the old-old (e.g., Hess et al., 2009). Our result could be attributable to the fact that both the young-old and the old-old groups perceived only a moderate stereotype threat, in terms of scores, preventing any differences between the two from becoming apparent. This issue needs to be further investigated in future studies to clarify whether or not young-old and old-old adults differ in their sensitivity to stereotypes.

As for the relationship between age, stereotype threat and map recall, correlation analyses showed that age was associated negatively with recall task performance and positively with perceived stereotype threat; and the perceived stereotype threat correlated significantly with map-drawing performance and with the verification test (but not with the pointing task). The fact that the correlation between stereotype threat and pointing task was not significant, would seem to confirm that stereotype threat is related to task difficulty, as suggested by Kang and Chasteen (2009).

The results of our mediation model better qualified the relationship between the variables, showing significant direct relations between age and spatial recall performance, and between age and perceived stereotype threat in all three models (each considering one of the three recall tasks). Perceived stereotype threat showed a direct relationship with spatial recall when measured with map drawing. The mediation model also showed that age affected map-drawing performance not only directly, but also through the mediation of perceived stereotype threat, whereas the effect of age on the verification test and pointing task was not mediated by perceived stereotype threat. This result indicates, overall, that age is the "best" predictor of performance in all the recall tasks. It was only when the spatial task involved recalling information in the same format and perspective (as in studying a map and then drawing it from memory) – which is a favorable condition for older adults – that perceived stereotype threat influenced performance. However, it did not intervene in the relationship between age and spatial performance when the recall tasks were theoretically classifiable as being more difficult, i.e. involving a change of either perspective (as in the pointing task) or format (as in the verification test). It is also possible, however, that given that those tasks are difficulty, the impact of the stereotype is null as participants' task performance was already poor.

This pattern of findings suggests that the objective difficulty of a given task could be seen as a crucial factor in the emergence of the effects of stereotype threat on age-related differences in cognitive performance, at least when spatial recall is required, as in our case. It seems that a core task for disclosing the effect of stereotype threat in aging should demand spatial recall without departing too much from the format and perspective learnt. This may also indicate that perceived stereotype threat comes to bear on both inputs (such as a map) and outputs (such as map drawing) that involve similar cognitive processes.

Our results are generally in line with the report from Kang and Chasteen (2009), showing that the impact of perceived stereotype threat is greater for certain types of recall task. Having said that, and partly because the above-mentioned authors also explored the effects of perceived (situational and dispositional) stereotype threat in relation to a manipulation of the stereotype threat (something that was not done here), further studies are needed to investigate the relationship in aging between spatial recall, perceived stereotype threat, and threat effects in aging.

The results of mediation analysis on map drawing can be interpreted also referring to the regulatory focus theory (Higgins, 1999): the stereotype may induce older adults to adopt a prevention focus, temporarily affecting their situational regulatory focus, so that they become more concerned with age-related losses (as suggested by Barber & Mather, 2014; Popham & Hess, 2013). Thus, for a task in which older adults have a better chance of performing well (such as map drawing in our case), the stereotype threat (concerning age and spatial abilities) may plausibly induce a prevention focus, making older adults focus more on their own decline and loses, and consequently hampering their final spatial performance. When the task is more difficult, on the other hand, older adults might already expect to be less competent and accurate per se, so their perceived stereotype threat may not further influence their performance.

The effect of task difficulty may therefore be not only objective, but also self-perceived. The role of a person's perception of the difficulty of a task is also consistent with the view that aspects relating to monitoring and stress can modulate the activation of stereotypes capable of influencing task performance (see Schmader, Johns, & Forbes, 2008). In our case, the stereotype may influence final performance when participants see the task as feasible and not particularly stressful, whatever the end result. It is important to add that this is mere speculation, since we did not measure subjective perception of task difficulty (or self-efficacy). In our study, task difficulty was objectively assumed from the literature on aging and the spatial domain. It will be useful in future to examine whether tasks perceived as challenging, but still feasible (e.g., O'Brien & Crandall, 2003; Keller, 2007), interact with stereotype threat in the same way as our objectively classified tasks in the present study. Approaching this issue would further broaden our understanding of stereotype and aging in the spatial domain.

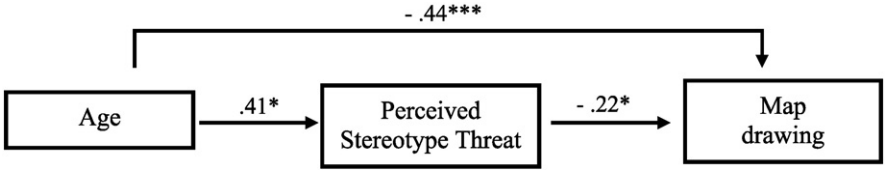

Fig. 1. Path model. Influence of age and perceived stereotype threat in map-drawing performance (standardized solutions in the path model). Note. $^{*}p < .05$, $^{***}p < .001$.

Taken together, our findings are important in the aging and stereotype threat domain, a line of research that has suffered from complex and sometimes inconsistent findings (as mentioned in Salthouse, 2009). From a cognitive viewpoint, our findings indicate that older adults (be they young-old or old-old) perform less well in spatial tasks than younger adults. The former's worse spatial performance could be attributed to the cost of spatial processing, for encoding, processing and retaining spatial information (Borella et al., 2014; Meneghetti, Borella, et al., 2011). The relationship between age and spatial performance is not only due to cognitive aspects, however. Indeed, taking a social-cognitive approach has newly shown that the relationship between age and spatial performance is mediated by individuals' perceived stereotype threat concerning aging and spatial abilities. But the influence of stereotype also depends on the spatial recall measure considered. After map learning, older adults recall performance in complex tasks (like our pointing task and verification test), which has been shown to decline in aging, and which resulted to be low here, was explained by their age per se, and the associated decline in cognitive resources (Meneghetti, Borella, et al., 2011). On the other hand, in a task in which older adults have a chance of performing adequately (such as map drawing after studying a map), their worse performance was explained not only by age, but also by social-cognitive factors such as stereotype. This leads us to conclude that social-cognitive factors such as stereotype, as well as aging, influence spatial performance in older adults.

Acknowledgments

This research was supported by a grant awarded to Erika Borella by the University of Padova (CPDA110373/11).

References

Baltes, P. B. (1987). Theoretical propositions of life-span developmental psychology: On the dynamics between growth and decline. *Developmental Psychology*, *23*, 611–626. http://dx.doi.org/10.1037/0012-1649.23.5.611.

Barber, S. J., & Mather, M. (2014). *Stereotype threat in older adults: When and why does it occur and who is most affected?* The Oxford Handbook of Emotion, Social Cognition, and Problem Solving in Adulthood. New York: Oxford University Press, 302–315.

Batschelet, E. (1981). *Circular statistics in biology*. New York: Academic Press.

Borella, E., Meneghetti, C., Muffato, V., & De Beni, R. (2014). Map learning and the alignment effect in young and older adults: How do they gain from having a map available while performing pointing tasks? *Psychological Research*http://dx.doi.org/10.1007/s00426-014-0543-y.

Burns, P. C. (1999). Navigation and the mobility of older drivers. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *54*, 49–55. http://dx.doi.org/10.1093/geronb/54B.1.S49.

Chasteen, A. L. (2000). The role of age and age-related attitudes in perceptions of elderly individuals. *Basic and Applied Social Psychology*, *22*, 147–156. http://dx.doi.org/10.1207/S15324834BASP2203_3.

Chasteen, A. L., Bhattacharyya, S., Horhota, M., Tam, R., & Hasher, L. (2005). How feelings of stereotype threat influence older adults' memory performance. *Experimental Aging Research*, *31*, 235–260. http://dx.doi.org/10.1080/03610730590948177.

Coluccia, E., Bosco, A., & Brandimonte, M. A. (2007). The role of visuospatial working memory in map learning: New findings from a map drawing paradigm. *Psychological Research*, *71*, 359–372. http://dx.doi.org/10.1007/s00426-006-0090-2.

Craik, F. I. M., & Salthouse, T. A. (2008). *Handbook of aging and cognition* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*, 189–198. http://dx.doi.org/10.1016/0022-3956(75)90026-6.

Hertzog, C., & Hultsch, D. F. (2000). Metacognition in adulthood and old age. In F. I. M. Craik, & T. A. Salthouse (Eds.), *Handbook of Aging and Cognition* (pp. 417–466) (2nd ed.). Mahwah, NJ: Lawrence Erlbaum.

Hess, T. M., Auman, C., Colcombe, S. J., & Rahhal, T. A. (2003). The impact of stereotype threat on age differences in memory performance. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *58*, 3–11. http://dx.doi.org/10.1093/geronb/58.1.P3.

Hess, T. M., Hinson, J. T., & Hodges, E. A. (2009). Moderators of and mechanisms underlying stereotype threat effects on older adults' memory performance. *Experimental Aging Research*, *35*, 153–177. http://dx.doi.org/10.1080/03610730802716413.

Higgins, E. T. (1999). Promotion and prevention as a motivational duality: Implications for evaluative processes. In S. Chaiken, & Y. Trope (Eds.), *Dual-Process Theories in Social Psychology* (pp. 503–525). New York: Guilford Press.

Horton, S., Baker, J., Pearce, G. W., & Deakin, J. M. (2008). On the malleability of performance: Implications for seniors. *Journal of Applied Gerontology*, *27*, 446–465. http://dx.doi.org/10.1177/0733464808315291.

ISTAT (2011). *Annuario Statistico Italiano 2011 [Italian Statistics Yearbook 2011]*. Roma: ISTAT.

Jöreskog, K. G., & Sörbom, D. (1981). *LISREL V: Analysis of Linear Structural Relationships by the Methods of Maximum Likelihood*. Chicago: National Educational Resources.

Kang, S. K., & Chasteen, A. L. (2009). The moderating role of age-group identification and perceived threat on stereotype threat among older adults. *The International Journal of Aging and Human Development*, *69*, 201–220. http://dx.doi.org/10.2190/AG.69.3.c.

Keller, J. (2007). Stereotype threat in classroom settings: The interactive effect of domain identification, task difficulty and stereotype threat on female students' maths performance. *British Journal of Educational Psychology*, *77*, 323–338. http://dx.doi.org/10.1348/000709906X113662.

Klencklen, G., Després, O., & Dufour, A. (2012). What do we know about aging and spatial cognition? Reviews and perspectives. *Ageing Research Reviews*, *11*, 123–135. http://dx.doi.org/10.1016/j.arr.2011.10.001.

Linn, M. C., & Petersen, A. C. (1985). Emergence and characterization of sex differences in spatial ability: A meta-analysis. *Child Development*, *56*, 1479–1498. http://dx.doi.org/10.1111/j.1467-8624.1985.tb00213.x.

Meneghetti, C., Borella, E., Grasso, I., & De Beni, R. (2011). Environment learning with map and/or description: age-related differences in young and older adults. *Journal of Cognitive Psychology*, *1*, 1–14. http://dx.doi.org/10.1080/20445911.2011.603694.

Meneghetti, C., Borella, E., Gyselinck, V., & De Beni, R. (2012). Age differences in environment route learning: The role of input and recall-test modalities in young and older adults. *Learning and Individual Differences*, *22*, 884–890. http://dx.doi.org/10.1016/j.lindif.2012.04.006.

Meneghetti, C., Borella, E., Muffato, V., Pazzaglia, F., & De Beni, R. (2014). Environment learning from spatial descriptions: The role of perspective and spatial abilities in young and older adults. In C. Freksa (Eds.), *Spatial Cognition 2014, LNAI 8684* (pp. 30–45)978-3-319-11214-5. http://dx.doi.org/10.1007/978-3-319-11215-2_12.

Meneghetti, C., Fiore, F., Borella, E., & De Beni, R. (2011). Learning a map of environment: The role of visuo-spatial abilities in young and older adults. *Applied Cognitive Psychology*, *25*, 952–959. http://dx.doi.org/10.1002/acp.1788.

O'Brien, L. T., & Crandall, C. S. (2003). Stereotype threat and arousal: Effects on women's math performance. *Personality and Social Psychology Bulletin*, *29*(6), 782–789. http://dx.doi.org/10.1177/0146167203029006010.

Orsini, A., & Laicardi, C. (2003). *Wais-R e terza età. La natura dell'intelligenza nell'anziano: Continuità e discontinuità [WAIS-R and the third age. The nature of intelligence in elderly people: continuity and discontinuity]*. Firenze: Giunti OS.

Popham, L. E., & Hess, T. M. (2013). Age differences in the underlying mechanisms of stereotype threat effects. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*http://dx.doi.org/10.1093/geronb/gbt093.

Richardson, A. E., Montello, D. R., & Hegarty, M. (1999). Spatial knowledge acquisition from maps and from navigation in real and virtual environments. *Memory & Cognition*, *27*, 741–750. http://dx.doi.org/10.3758/BF03211566.

Salthouse, T. (2009). *Major issues in cognitive aging*. Oxford University Press.

Schmader, T., Johns, M., & Forbes, C. (2008). An integrated process model of stereotype threat effects on performance. *Psychological Review*, *115*, 336–356. http://dx.doi.org/10.1037/0033-295X.115.2.336.

Shapiro, J. R., & Neuberg, S. L. (2007). From stereotype threat to stereotype threats: Implications of a multi-threat framework for causes, moderators, mediators, consequences, and interventions. *Personality and Social Psychology Review*, *11*, 107–130. http://dx.doi.org/10.1177/1088868306294790.

Shelton, A. L., & McNamara, T. P. (2001). Systems of spatial reference in human memory. *Cognitive Psychology*, *43*, 274–310. http://dx.doi.org/10.1006/cogp.2001.0758.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist*, *52*, 613–629. http://dx.doi.org/10.1037/0003-066X.52.6.613.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*, *69*, 797–811. http://dx.doi.org/10.1037/0022-3514.69.5.797.

Taylor, H. A., & Tversky, B. (1992). Spatial mental models derived from survey and route descriptions. *Journal of Memory and Language*, *31*, 261–292. http://dx.doi.org/10.1016/0749-596X(92)90014-O.

Thorndyke, P. W., & Hayes-Roth, B. (1982). Differences in spatial knowledge acquired from maps and navigation. *Cognitive Psychology*, *14*, 560–589. http://dx.doi.org/10.1016/0010-0285(82)90019-6.

Tolman, E. C. (1948). Cognitive maps in rats and men. *Psychological Review*, *55*, 189–208. http://dx.doi.org/10.1037/h0061626.

Wechsler, D. (1981). *Wechsler adult intelligence scale* (rev. ed.). New York, NY: Psychological Corporation.

Wilkniss, S. M., Jones, M. G., Korol, D. L., Gold, P. E., & Manning, C. A. (1997). Age-related differences in an ecologically based study of route learning. *Psychology and Aging*, *12*, 372–375. http://dx.doi.org/10.1037/0882-7974.12.2.372.

Wolbers, T., & Hegarty, M. (2010). What determines our navigational abilities? *Trends in Cognitive Sciences*, *14*, 138–146. http://dx.doi.org/10.1016/j.tics.2010.01.001.

Yamamoto, N., & DeGirolamo, G. J. (2012). Differential effects of aging on spatial learning through exploratory navigation and map reading. *Frontiers in Aging Neuroscience*, *4*, 1–7. http://dx.doi.org/10.3389/fnagi.2012.00014.