



When less intergenerational closeness helps: The influence of intergenerational physical proximity and technology attributes on technophobia among older adults

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ABSTRACT

Intergenerational contact for technology learning frequently transpires in various daily settings of older adults' lives. However, older adults often hold negative age-based self-stereotype that they are less capable in technology use. Thus, they may experience age-based stereotype threats in such situations, which further induce technophobia. Previous research indicated that positive intergenerational contact can reduce age-based stereotype threat and technophobia among older adults. This research focuses on intergenerational physical proximity, a vital role in structuring intergenerational contact, to investigate how it impacts technophobia via age-based stereotype threat among older adults. In addition, the moderating effect of key attributes of technology—newness and ease of use were explored. A vignette experiment was conducted with a sample of 243 older adults. Results show that more distant intergenerational physical proximity led to lower technophobia-personal failure dimension via more positive self-perception of aging (a manifestation of less age-based stereotype threat) when the technology is of high newness and low ease of use. However, the effect of physical proximity on technophobia was insignificant when the technology is of low newness, or of high newness but high ease of use. The findings of this research can provide detailed and practical suggestions on how to reduce technophobia among older adults through effective intergenerational contact.

1. Introduction

The rapid development of technologies has brought the whole society into a new digital era. However, older adults, compared with younger adults who are seen as digital natives, are often negatively stereotyped as less capable in new technology use due to their age (Alexopoulou, 2020; Levy, 2009; McDonough, 2016). This stereotype contributes to older adults' technophobia, which is an anxiety about and overall negative attitudes towards technology and its societal impact (Khasawneh, 2018b; Mariano, Marques, Ramos, Gerardo, & de Vries, 2020; Xi, Zhang, & Ayalon, 2021). With this background, intergenerational contact for technology learning and reducing technophobia frequently happens in various daily settings of older adults' lives. For example, older parents can be taught with new technologies at home by their children, older customers may be helped by young salespersons in

technological products stores, older adults may acquire training from younger volunteers in technology training programs and so on (Reis, Mercer, & Boger, 2021). Some advertisements of technological products targeted at older consumers also universally represent portrayals of intergenerational contact. However, little is known in which way intergenerational contact in technology-related contexts can reduce technophobia among older adults.

Physical proximity, defined as the physical distance between two interactors, is one obvious situational variable that plays a vital role in structuring how older and younger adults contact (Becker, Gield, & Froggatt, 1983; Xiao, Wohl, & Van Bavel, 2016).

This research aims to investigate how intergenerational physical proximity impacts technophobia among older adults during intergenerational contact-based technology learning. In theorizing about the underlying process, we build on stereotype threat theory (Steele, 1997;

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Steele & Aronson, 1995) and intergenerational contact theory (Pettigrew, 1998) to posit that positive experiences of intergenerational contact shaped by optimal physical proximity can reduce age-based stereotype threat among older adults, a fear of confirming negative age-stereotypes (Abrams, Eller, & Bryant, 2006; Abrams et al., 2008; Becker et al., 1983; Xiao et al., 2016), which can further reduce negative psychological consequences, including technophobia (Xi et al., 2021). In addition, stereotype threat theory proposes that stereotype threat only occurs when the situation is diagnostic of one's stereotype relevant ability (Wheeler & Petty, 2001). Accordingly, two key attributes of technology, namely, technology newness and ease of use, which determine the difficulty of technology use, may be diagnostic of older adults' technology-related competence (Lee, Ha, & Widdows, 2011). We thus also explore whether the effect of intergenerational physical proximity on technophobia among older adults is moderated by these two technology attributes.

This research provides detailed and practical suggestions on how to reduce technophobia among older adults through effective intergenerational contact, which can further help promote the inclusion of older adults in today's technology-based society and narrow the age-based digital divide (Cotten, 2017; Kottl, Cohn-Schwartz, & Ayalon, 2020; Mariano et al., 2020).

2. Literature review and Conceptual Framework

2.1. Technophobia among older adults

The concept of technophobia was originated from computer anxiety or computer phobia, which indicates a negative psychological reaction specifically to computers (Brosnan, 1998; Maricutoiu, 2014; Rosen & Sears, 1987). However, technophobia indicates anxiety towards a broader range of technologies and is also equated as technology anxiety in some research (Gilbert, Lee-Kelley, & Barton, 2003; Venkatesh & Davis, 2000). Many researchers suggested that technophobia should be a multi-dimensional concept, two aspects of technophobia are prevalently proposed by different researchers (Khasawneh, 2018b; Martínez-Córcoles, Teichmann, & Murdvee, 2017). One key dimension of technophobia is the fear of personal failure towards technology use, which mainly indicates the overall fear and anxiety towards technology. The other dimension is human vs. machine ambiguity, which indicates the fear of negative societal impact from new technologies, such as the machine will take over the society (Osiceanu, 2015; Sinkovics, Stöttinger, Schlegelmilch, & Ram, 2002).

Some personal factors are correlated with technophobia, including demographic background (e.g. age, gender, education level and physical health) (Gilbert, Lee-Kelley, & Barton, 2003; Nimrod, 2018), dispositional traits (e.g. openness, neuroticism and extraversion) and cognitive processing skills (e.g. math and logic skills) (Korukonda, 2005; Maricutoiu, 2014). Older adults with certain characteristics, such as declining cognitive function or decreasing openness to experience with age, have more technophobia than younger people (McCrae et al., 1999). Another branch of studies has pointed out that due to declining physiological and psychosocial conditions in later age (Gell, Rosenberg, Demiris, LaCroix, & Patel, 2015; Jokisch, Schmidt, Doh, Marquard, & Wahl, 2020; Schmader, Johns, & Forbes, 2008), technophobia among older adults can be particularly affected by the negative perceptions of technology self-efficacy—the belief in one's own competence to achieve a desired goal and cope with a broad range of stresses and challenges in technology use (Bandura, 1977; Czaja et al., 2006; Di Giacomo, Guerra, Perilli, & Ranieri, 2020; Jokisch et al., 2020). Intervention studies specifically targeting older adults have provided more supporting evidence. It has shown that technology anxiety decreased after older adults' participation in self- or instructor-directed training (Xie & Bugg, 2009), collaborative learning (Xie, 2011) and intergenerational mentoring (O. E.-K. Lee & Kim, 2018; Shedletsky, 2006), whereas self-efficacy improved by accumulating technology experience during the

intervention.

Social factors, such as the pervasive negative age-stereotype in technology domains (e.g., older adults are lacking sufficient technology skills), can also increase technophobia when being activated by certain contextual cues, which is particularly true for older adults (Kottl et al., 2020; Köttl, Gallistl, Rohner, & Ayalon, 2021; Xi et al., 2021), due to its negative effect on older adults' technology self-efficacy (Levy, Hausdorff, Hencke, & Wei, 2000; Wheeler & Petty, 2001). This research focuses on such social factor, i.e., negative age-stereotypes, to investigate its influence on technophobia among older adults.

2.2. Effect of intergenerational physical proximity on age-based stereotype threat and its impact on technophobia

2.2.1. Age-based stereotype threat and its negative consequences

Strong evidence suggests that the global category "older people" falls into the warm and incompetent cluster of stereotyped groups (Cuddy, Fiske, & Glick, 2008; Fiske, Cuddy, Glick, & Xu, 2002). The stereotype of incompetence implies that older adults are seen as being less intelligent and as having less ability in various daily domains. Based on stereotype threat theory (Steele, 1997; Steele & Aronson, 1995), older adults who are negatively stereotyped as having low competence are likely to experience age-based stereotypes threat when negative age-stereotypes become salient (Lamont, Swift, & Abrams, 2015; Wheeler & Petty, 2001). For example, cognitive tests that explicitly mention age differences, or the mere presence of young people in a consumption setting where anti-aging culture prevails, may induce the fear of confirming negative age self-stereotypes among older adults (Abrams et al., 2006, 2008; Amatulli, Peluso, Guido, & Yoon, 2018). Furthermore, stereotype threat is anxiety provoking and may cause a series of negative consequences upon stereotyped groups (Bosson, Haymowitz, & Pinel, 2004; O'Brien & Crandall, 2003; Osborne, 2001, 2007).

Age-based stereotype threat also enhances overall anxiety among older adults (Abrams et al., 2006; Hess, Auman, Colcombe, & Rahhal, 2003; Kang & Chasteen, 2009) and anxiety towards certain issues, such as health anxiety (Cheng, 2020) and technophobia (Xi et al., 2021). Moreover, a behavioural response to stereotype threat is to avoid engagement in stereotype-related domains (Steele, Spencer, & Aronson, 2002). Older adults' age-based stereotype threat experience in the technology domain significantly predicted lower levels of computer use a year and a half later (Mariano et al., 2020).

2.2.2. Effect of positive intergenerational contact on age-based stereotype threat

Based on intergroup contact theory (Pettigrew, 1998), a positive intergroup relationship or contact experience may weaken ingroup identification by making group boundaries less salient and reducing people's anxiety about being judged by the dominant outgroup by building intergroup trust and closeness (Abrams et al., 2006; McLaughlin-Volpe, Aron, Wright, & Lewandowski, 2005). Thus, when older adults perceive the experience of intergenerational contact as positive, it can decrease age-based stereotype threat (Hutchison, Fox, Laas, Matharu, & Urzi, 2010). Older adults who had actual positive physical contact with younger people or even merely imagined details of positive intergenerational contact showed less anxiety and performed better in math-related tasks than those who did not have any form of intergenerational contact (Abrams et al., 2006, 2008). However, existing studies failed to investigate specific ways in which intergenerational contact was effective in reducing age-based stereotype threat among older adults.

2.2.3. Physical proximity and perceived positive interpersonal contact

Becker et al. (1983) indicated that any given interaction is influenced by a complex array of factors, such as culture, personal feature and subtle contextual cues. Among these, physical proximity is an important contextual factor in affecting how people interact and the perception of

the situation (Dijksterhuis, Smith, Baaren, & Wigboldus, 2005; Xiao et al., 2016; Zhu & Argo, 2013; Zweigenhaft, 1976). Rosenfeld (1965) found that, in some instances, the narrower the interpersonal distance, the better people were able to show and feel friendliness and equality, and the wider the interpersonal distance, the more aloofness was conveyed. The specific placement of people in physical proximity can also affect perceived social status and interaction positivity (Lott & Sommer, 1967). In some settings, sitting side-by-side is perceived as more informal than sitting face-to-face across a table, leading to higher perceived closeness, egalitarianism and better evaluation of the other person, which can even facilitate interpersonal co-operation (Becker et al., 1983; Sommer, 1969; Zweigenhaft, 1976).

Contrarily, other research has found that greater interpersonal distance can mitigate perceived situational threat which is conveyed by detailed visual cues from the other side, such as facial expression, eye contact and posture (Stamps, 2011). For example, Lott and Sommer (1967) found that people were more likely to sit further from individuals of higher status than their peers and were more likely to sit across a table from individuals of higher status rather than side-by-side to keep distance from potential pressure from the superior. Similarly, Xiao et al. (2016) unveiled that experimental induction of physical proximity to a threatening outgroup, such as an opponent sports team, made people feel more animosity, which further affected their choice on sitting more distantly from outgroup members (e.g., opponent sports team fans). Williams and Bargh (2008) uncovered that priming spatial distance (vs. closeness) through two arbitrary objects' distance without reference to the self, that is plotting an assigned set of points on a Cartesian coordinate plane, can help reduce the negative emotion after reading embarrassing stories or violent stories. One explanation for these findings is that keeping a distance from potential threats has adaptive significance for animals' survival (Clark, 1973). The principle that "distance equals safety" is deeply ingrained in our brains. In intergroup interaction, physical proximity to a threatening outgroup can place one at risk of losing social status or resources (Xiao et al., 2016).

Thus, we can expect that in intergenerational contact for technology learning, older adults with negative age-based self-stereotypes that they are lacking insufficient technology skills are likely to experience age-based stereotype threat, especially when they are facing younger adults who are believed as the dominant group in the technology domain. By weakening ingroup identification and lessening the sense of intergroup boundaries, a positive intergenerational contact can ameliorate the age-based stereotype threat and negative self-perceptions of aging (SPA) (Aarts & Dijksterhuis, 2002; Abrams et al., 2006, 2008).

When older adults and younger people have closer physical proximity during contact, such as when they are sitting side-by-side, the feeling of friendliness and perception of equal status is greater than when they are more physically distant (e.g., sitting face-to-face across a table). Closer physical proximity in intergenerational contact has been found to create a more positive interaction experience among older adults (Becker et al., 1983). However, more intergenerational physical distance may help older adults reduce the perception of outgroup threat, which may be imposed by younger people (Xiao et al., 2016).

Therefore, we assume that physical proximity in intergenerational contact would affect technophobia among older adults, but the effect of intergenerational physical distance or closeness remains unclear. This raises the following hypotheses and research question:

H1. Intergenerational physical proximity will affect technophobia among older adults in intergenerational contact-based technology learning.

2.3. Self-perception of aging as a manifestation of age-based stereotype threat

Stereotype embodiment theory suggests that age-stereotype differs from other types of stereotypes (e.g., race, gender), given that negative

age-based stereotypes may be internalized and become negative self-stereotypes after years of exposure to ageist environments, older adults are thus at risk of experiencing self-as-source stereotype threat, where the threat comes from the stereotypes that they themselves have internalized rather than from stereotypes merely held by others (Levy, Slade, & Kasl, 2002; Shapiro, 2011). Older adults may feel concerned that they will confirm in their own minds, apart from in others' minds, that negative age stereotypes are true of themselves (Barber, 2017). Age-based stereotype threat experience amongst older adults can thus be manifested as negative SPA—a negative view of one's own aging process (Brothers, Kornadt, Nehr Korn-Bailey, Wahl, & Diehl, 2020; Levy, 2009). Therefore, we can expect that the effect of intergenerational physical proximity on age-based stereotype threat can be manifested as an impact on self-perception of aging.

A few studies have examined the direct effect of age-based stereotype threat on SPA (Hausknecht, Low, O'Loughlin, McNab, & Clemson, 2020). However, some experiments have uncovered that priming negative (vs. positive) age-stereotype related words induced more negative SPA (Cheng, 2020; Levy, 1996). Moreover, longitudinal studies that focused on SPA found that positive age stereotypes held by older adults can positively predict later gain aspects of SPA but negatively predict loss aspects of SPA (Brothers et al., 2020). Meanwhile, negative SPA negatively predicts older adults' self-efficacy over time (Klusmann, Sproesser, Wolff, & Renner, 2017; Tovel, Carmel, & Raveis, 2017), which is an important influential factor on technophobia and technology adoption intention (Korukonda, 2005; Maricutoiu, 2014). Thus, we further hypothesize that:

H2. Self-perception of aging will negatively predict technophobia among older adults.

H3. Self-perception of aging will mediate the relationship between intergenerational physical proximity and technophobia among older adults in intergenerational contact-based technology learning.

2.4. Technology newness and ease of use: technology attributes define age-based stereotype threat condition

Previous research has investigated conditions in which stereotype threat can occur. Stereotype threat only arises when the situation is diagnostic of one's stereotype relevant ability, and the difficulty of the task, which is informative regarding one's abilities, may therefore affect stereotype threat (Wheeler & Petty, 2001). For example, women experienced gender-based stereotype threat and showed worse performance when the difficulty of a math test was high, but no gender difference existed when the math test difficulty was low (Spencer & Steele, 1999). When it comes to technology acceptance, two attributes of technology determine the difficulty of technology use, which may be diagnostic of older adults' stereotyped abilities in terms of technology and define age-based stereotype threat condition (Lee et al., 2011).

One is the newness of the technology, meaning the extent to which the technology is new and unique to consumers (Luo, Wong, & Chou, 2016). Some studies have shown that technology newness significantly affects attitudes towards technology. Specifically, the higher newness the technology, the more avoidant people's attitudes towards it are and the less likely they are to adopt it (Hoeffler, 2003; Luo et al., 2016). People often have insufficient knowledge about highly innovative technology products and therefore perceive them as unfamiliar and unclear. Highly new technological products require more effort to learn and usually require a change of familiar technology use habits (Moreau, Markman, & Lehmann, 2001; Rao & Monroe, 1988). Therefore, people may perceive newness as a risk rather than a benefit when deciding whether to adopt a particular technology (Ma, Yang, & Murali, 2014).

The other attribute is the technology's ease of use, which is the degree to which one perceives that technology adoption will be free of effort, it is mostly manifested in the process of technology product use (Davis, 1989). Numerous studies that specifically focused on older

adults have shown that perception of high ease of use of technology can effectively predict older adults' positive attitudes towards information, communication, assistive, health-related technologies and so on (Kavandi & Jaana, 2020; Ma, Chan, & Teh, 2021; Niehaves & Plattfaut, 2017). Perceived ease of use is more important for older adults' attitudes towards technology adoption than younger people's (Hauk, Hüffmeier, & Krumm, 2018; Pal, Funilkul, Charoenkitkarn, & Kanthamanon, 2018; Pan & Jordan-Marsh, 2010; Zhao, Hoeffler, & Zauberman, 2018). In addition, older adults with declining sensory perceptions and cognition expressed greater anxiety the more they perceived the technological devices to be complex and laborious (Heinz et al., 2013).

Overall, technology newness and ease of use may affect the occurrence of age-based stereotype threat among older adults. More importantly, compared to technology's ease of use, technology newness, which describes what the technology is and serves as a more primary information when a particular technology is firstly introduced to older adults, should be a more important attribute in affecting the perceived situational threat (Ma et al., 2021; Rao & Monroe, 1988). Therefore, we assume that the influence of technology's ease of use on older adults' perception of situation threat will depend on technology newness. Thus, we propose the following hypotheses and research question:

H4. Technology newness moderates the mediating relationship between intergenerational physical proximity and technophobia via self-perception of aging such that the mediating relationship will be stronger when technology newness is high (vs. low).

H5. Technology ease of use moderates the mediating relationship between intergenerational physical proximity and technophobia via self-perception of aging such that the mediating relationship will be stronger when technology ease of use is low (vs. high).

H6. Technology newness will moderate the moderating effect of technology newness on the mediating relationship between intergenerational physical proximity and technophobia via self-perception of aging among older adults in intergenerational contact-based technology learning, such that the moderated mediation effect will be stronger when technology newness is high (vs. low).

To examine the hypotheses and research question, we propose the following figure, which outlines a comprehensive account of the varied hypotheses and research questions (Fig. 1).

3. Method

3.1. Participants

Sample size was determined by conducting a power analysis in G*Power. The analysis indicated that in testing the interaction effect of intergenerational physical proximity \times technology ease of use \times technology newness on technophobia, a sample of 210 would be sufficient for a medium effect size of 0.25 to be detected with 95% power and significance level at 0.05. Therefore, 250 older participants aged over 55 were recruited from among the residents of a retirement community and a nursing home in Beijing, China. A minimum age of 55 for our sample

was chosen because the average retirement age in China is 55 (People.cn, 2015). Seven participants dropped out before the study was completed. A total of 243 participants completed the experiments and their data were collected. The average age was 67.19 years (ranging from 55 to 90 years; SD = 7.25). The sample included 123 women (50.6%) and 120 men.

3.2. Procedure

This study was a three-factor between-subjects design. Eight experimental conditions were created with the combination of two portrayals of intergenerational physical proximity, two levels of technology newness and two levels of technology ease of use. The study passed the ethical approval of the Institutional Review Board of the School of Psychological and Cognitive Sciences, Peking University. The experiment was conducted at the retirement community and the nursing home where the participants lived. Participants signed a consent form and were then randomly assigned to one of the eight conditions and received a printed questionnaire accordingly. They were told that the experiment was about their perception of a technology product and that they would need to read a technology advertisement before answering the questions. After reading the advertisement, participants reported their self-perception of aging and technophobia in the questionnaire. Basic demographic information was also collected, including gender and age, as well as potential covariates. Lastly, each participant was paid 5RMB after completing the experiment.

3.3. Stimuli design and manipulation check

The stimuli in this study comprised two parts, one was a pictorial stimulus, which portrays intergenerational contact for technological product introduction and learning, the other was the introduction of technological product's newness and ease of use. However, to design the stimuli, one pair of technological products of high newness and low newness as pre-test was firstly selected, and then the stimuli of the chosen technology's ease of use were re-designed. On the basis of the first step, the stimuli of intergenerational physical proximity that centres on the chosen technology were designed.

3.3.1. Stimuli of technological products newness

Five technological products of high newness were selected by searching the list of newly launched technology products on JD.com (the most popular e-commerce platform in China) during our research (in September 2020). Then, verbal description of high and low technology-newness of these products were designed on the basis of real advertisements. To select the valid experimental stimulus for technology newness, an online pretest with 21 participants (M = 67.89, SD = 6.15, age range from 60 to 83, 71% females) was conducted by showing them five technological products' newness descriptions randomly. Each technological product's description was either of high newness or low newness (see Appendix A Table 1 for details). Participants were asked to rate their perception of technology newness (1 = *not new at all*; 8 = *very new*), and results show that among five technological products, only the

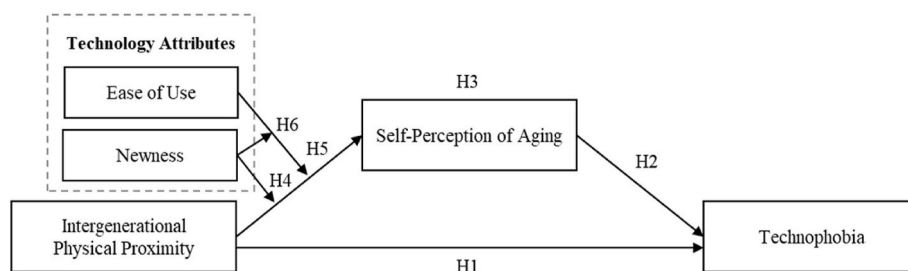


Fig. 1. Conceptual framework.

Table 1

Descriptive statistics and intercorrelation among variables.

	M	SD	Gender	Age	SPA	TP-PF	TP-HMA	TP-C	SH	SSS	TUE
Gender	.51	.50	–								
Age	67.19	7.25	-.13	–							
Self-perception of aging (SPA)	5.78	.79	.04	-.17**	–						
Technophobia-personal failure (TP-PF)	2.74	1.09	-.03	.05	-.34**	–					
Technophobia-human vs. machine ambiguity (TP-HMA)	5.22	1.30	-.02	.20**	-.01	-.16*	–				
Technophobia-convenience (TP-C)	2.92	1.12	.03	.03	-.29**	.57**	-.11	–			
Subjective health (SH)	4.36	1.24	.12	-.08	-.02	.11	-.22**	.06	–		
Subjective socioeconomic status (SSS)	3.27	1.60	.16*	.03	-.10	.17**	-.08	.10	.20**	–	
Technology use experience (TUE)	3.79	1.49	-.03	-.08	-.06	.16*	-.42**	.17**	.14*	.17**	–

Notes: n = 243; M = means; SD = standard deviation; * $p < 0.05$, ** $p < 0.01$ (two-tailed).

manipulation of the humidifier's newness was valid. Specifically, to control the perception of usefulness of technology, it was stated that the major function of the humidifier was to humidify the dry environment at home. The humidifier of high newness was introduced as an artificial-intelligence-based humidifier robot with breakthrough technology ($M = 6.55$, $SD = 1.37$). Low newness was introduced as a commonly seen "smart" humidifier with upgraded technology ($M = 5.00$, $SD = 1.94$; $F(1, 19) = 2.78$, $p < 0.05$, $\eta^2 = 0.19$). The humidifier was chosen as our focal technological product.

3.3.2. Stimulus of technology's ease of use

To manipulate the ease of use of the humidifier, two pictures of buttons were designed as stimulus (see Appendix A). For high level ease of use, a picture of the humidifier's single operational button was designed, and it was stated that it can be operated with just one button and a simple voice control. For low level ease of use, a picture of eight operational buttons was designed, and it was stated that it can be operated with eight buttons and a multi-functional mobile control. For the manipulation check, the same participants in the manipulation check for stimuli of technological products' newness were invited and were asked to rate the perception of ease of use (1 = *very easy to use*; 8 = *very uneasy to use*). Results unveil that one button ($M = 2.09$, $SD = 1.76$) was rated as significant higher ease of use than eight buttons ($M = 3.90$, $SD = 1.73$; $F(1, 19) = 5.63$, $p < 0.05$, $\eta^2 = 0.23$), which demonstrated that the manipulation was valid.

3.3.3. Stimulus of intergenerational physical proximity

To prime different levels of intergenerational physical proximity, the stimulus that portrayed an instance of intergenerational contact in a technology-related situation was designed (see Appendix A). In this picture, an older woman/man and a young adult of the same gender explored a humidifier together. In the manipulation of high intergenerational physical proximity, the older woman/man and young woman/man were sitting side-by-side on the same side of the table. In the manipulation of low intergenerational physical proximity, the older woman/man and young woman/man were sitting face-to-face at opposite sides of the table. To avoid potential gender bias, the gender of the respondent was matched to the gender displayed in the pictures.

As a manipulation check on the portrayal of intergenerational physical proximity, another 20 older adults were recruited online ($M = 67$; $SD = 8.06$; age range from 57 to 88; 50% females) and were showed either a picture of an older adult and a young adult sitting side-by-side or a picture of an older adult and a young adult sitting face-to-face across a table. The participants were asked to rate the perceived physical proximity between the people in the picture (1 = *very distant*, 8 = *very close*). The results show that participants considered the people sitting side-by-side ($M = 4.67$, $SD = 0.87$) to be significantly closer than those sitting face-to-face ($M = 3.45$, $SD = 1.29$; $F(1, 18) = 5.76$, $p < 0.05$, $\eta^2 = 0.24$). On the basis of these results, our manipulation on intergenerational physical proximity are valid. Participants were also asked to rate their feelings about the portrayal of intergenerational contact (1 = *very negative*, 8 = *very positive*). The results show that participants rated the

intergenerational contact of side-by-side sitting ($M = 5.00$, $SD = 1.00$) significantly more positively than the portrayal of face-to-face sitting ($M = 4.09$, $SD = 0.94$; $F(1, 18) = 4.36$, $p = 0.05$, $\eta^2 = 0.20$).

3.4. Measurement

Mediator: Self-Perception of Aging (SPA). To measure SPA, the Self-Image of Aging Scale (SIAS) was used, which was originally developed by Levy (2004). In our study, the Chinese version developed by Cheng, Yip, Jim, and Hui (2012) was used, because it has been tested among Chinese older adults in several studies and showed good reliability (Cheng et al., 2012; Fung et al., 2015). The Chinese version of the scale includes nine positive words and nine negative words that describe positive and negative images of older people within nine domains. An 8-point Likert scale was used in our questionnaire. Participants were asked to rate the extent to which certain phrases matched their perception of their own aging. The positive phrases included *walk active, well-groomed, wise/full of life, capable, having a positive outlook, healthy, family-oriented and having the will to live*. The negative phrases included *walk slowly, wrinkled, senile, dying, helpless, grumpy, sick, lonely and giving up*. The score of the negative words rating was reversed, hence a higher score indicates a more positive SPA. The Cronbach's alpha of the SPA scale is 0.80.

3.4.1. Dependent variable: technophobia

The technophobia scale of Sinkovics et al. (2002) was adopted in this study. The scale includes a 13-item scale and three dimensions of technophobia were measured: 1) fear of personal failure, which mainly indicates the fear and anxiety towards technology; 2) human vs. machine-ambiguity, which emphasized the fear of negative societal impact from new technologies; 3) perceived convenience, which reflected the perception towards technology from a positive perspective. Participants were asked to indicate to what extent do they agree with each statement on an 8-point Likert scale (1 = *strongly disagree*, 8 = *strongly agree*). Nimrod (2018, 2021) had proved the reliability and validity of the scale developed by Sinkovics et al. (2002) exclusively among older adults. The original scale was translated into Chinese and translated back to English by different researchers to ensure the scale retained its original meaning. The Cronbach's alpha of the first and third subscales were 0.87 and 0.85. For the second subscale, one item "I prefer to have people handle my concerns rather than to use this technology" was deleted, and the Cronbach's alpha increased from 0.50 to 0.78. The Cronbach's alpha of the overall scale was 0.78.

3.4.2. Potential covariates

Subjective health and experience of technology use were negatively associated with technophobia among older adults (Di Giacomo et al., 2020; Nimrod, 2018, 2021). We therefore measured subjective health (1 = *very bad*; 8 = *excellent*), technology usage experience (1 = *very limited*, 8 = *very rich*). In addition, socioeconomic status (e.g., education, work status, income) was also found to be correlated with technophobia (dos Santos & Santana, 2018; Nimrod, 2018, 2021). Therefore,

subjective social status was measured by using the MacArthur Scale of Subjective Social Status (Adler, Epel, Castellazzo, & Ickovics, 2000) (1 = *very low*, 10 = *very high*) as potential covariates, given that it can represent a person's overall sense of socioeconomic status.

4. Results

4.1. Preliminary analysis

Descriptive statistics and the correlation matrix of examined variables is shown in Table 1. Given that we aim to examine the three-way interaction effect of intergenerational physical proximity, technology newness and technology ease of use, we conducted a preliminary analysis by testing the differences between these eight groups on potential covariates, including chronological age, subjective health, subjective social status and technology use experience, to check whether randomization was successful (Fives et al., 2013). Results reveal that none of these variables significantly differed across the experimental conditions ($p.s. > 0.05$) (see Table 2). Thus, we did not include them as covariates in the following statistical analysis. However, statistically controlling for these variables did not affect the following analyses reported.

4.2. Self-perception of aging

We conducted a 2 (intergenerational physical proximity: near vs. distant) \times 2 (ease of use: low vs. high) \times 2 (newness: low vs. high) three-way ANOVA analysis on SPA (see Table 3). We found that the main effect of newness was significant ($F(1, 235) = 5.71, p < 0.05, \eta^2 = 0.02$). Technology of high newness led to significantly more negative self-perception of aging ($M_{low} = 5.66, SD = 0.80; M_{high} = 5.89, SD = 0.76$). Two-way interaction effects of intergenerational physical proximity \times technology ease of use or intergenerational physical proximity \times technology newness was not significant ($p > 0.10$).

However, more importantly, we found a significant three-way interaction effect of intergenerational physical proximity \times ease of use \times newness ($F(1, 235) = 4.50, p < 0.05, \eta^2 = 0.02$). Specifically, the interaction effect of intergenerational physical proximity \times ease of use was significant when the technology newness was high ($F(1, 235) = 6.63, p < 0.05, \eta^2 = 0.03$), but not when the technology newness was low ($F(1, 235) = 0.15, p > 0.05, \eta^2 = 0.00$). Under the condition of high newness, we further tested the effect of physical proximity under the condition of low ease of use. The results show that more distant physical proximity ($M = 6.05, SD = 0.74$) led to a significantly more positive SPA compared with closer physical proximity ($M = 5.45, SD = 0.64; F(1, 235) = 8.78, p = 0.00, \eta^2 = 0.04$), but the effect of physical proximity was insignificant when the ease of use was high ($F(1, 235) = 0.42, p > 0.05, \eta^2 = 0.00$). This test also indicated that under the condition of high technology newness, the more distant intergenerational physical proximity (sitting face-to-face) even led to significantly more positive SPA when the technology was perceived to be hard to use compared with

when the technology was perceived to be easy to use ($F(1, 235) = 7.55, p < 0.05, \eta^2 = 0.03$) (see Fig. 2).

4.3. Technophobia

We followed the same procedures to analyze the influence of intergenerational physical proximity, ease of use and newness in each dimension of technophobia. The results of the MANOVA analysis unveil that the main effect of newness was significant for each dimension of technophobia (Wilks' lambda = 0.96, $F(1, 235) = 2.94, p < 0.05, \eta^2 = 0.04$). Specifically, the effect of technology newness was significant on technophobia-personal failure dimension ($F(1, 235) = 4.97, p < 0.05, \eta^2 = 0.02$) and human vs. machine ambiguity dimension ($F(1, 235) = 6.56, p < 0.05, \eta^2 = 0.03$). High newness led to higher technophobia on the dimension of personal failure ($M_{high} = 2.89, SD = 1.15; M_{low} = 2.59, SD = 1.01$) and on human vs. machine ambiguity ($M_{high} = 3.11, SD = 1.25; M_{low} = 2.74, SD = 0.95$). None of the two-way interaction effects was significant ($p.s. > 0.09$).

More importantly, we found that the three-way interaction of intergenerational physical proximity \times ease of use \times newness to be significant for each dimension of technophobia (Wilks' lambda = 0.97, $F(1, 235) = 2.53, p = 0.05, \eta^2 = 0.03$), but the interaction effect was only significant on technophobia-personal failure dimension ($F(1, 235) = 5.17, p < 0.05, \eta^2 = 0.02$) (see Table 3). Further analysis showed that intergenerational physical proximity \times ease of use was marginally significant when the technology newness was high ($F(1, 235) = 3.40, p = 0.06, \eta^2 = 0.01$), but not when the technology newness was low ($F(1, 235) = 1.85, p > 0.05, \eta^2 = 0.01$). A simple effect analysis showed that in the condition of high newness and low ease of use, more distant intergenerational physical proximity (sitting face-to-face) ($M = 2.64, SD = 0.93$) led to significantly lower technophobia-personal failure dimension than closer physical proximity (sitting side-by-side) ($M = 3.35, SD = 1.22; p < 0.05; F(1, 235) = 6.31, p < 0.05, \eta^2 = 0.03$), but the effect of physical proximity was insignificant in the condition of high ease of use ($F(1, 235) = 2.06, p > 0.05, \eta^2 = 0.01$). In addition, in the condition of high newness, the effect of ease of use was significant when the intergenerational contact was of close physical proximity (sitting side-by-side) ($F(1, 235) = 3.98, p = 0.05, \eta^2 = 0.02$), but not when the contact was more distant ($F(1, 235) = 0.37, p > 0.05, \eta^2 = 0.00$) (see Fig. 3). Therefore, H1 was supported, intergenerational physical proximity affects technophobia among older adults. Furthermore, results show that low intergenerational physical proximity induced lower technophobia among older adults.

4.4. Moderated mediating effect of SPA on the personal failure dimension of technophobia

To further investigate the underlying mechanism of self-perception of aging, we ran moderated mediation models in Mplus 8.0. Given that the three-way interaction effect of intergenerational physical proximity \times ease of use \times newness was significant only on the

Table 2
Sample characteristics at baseline by experimental condition.

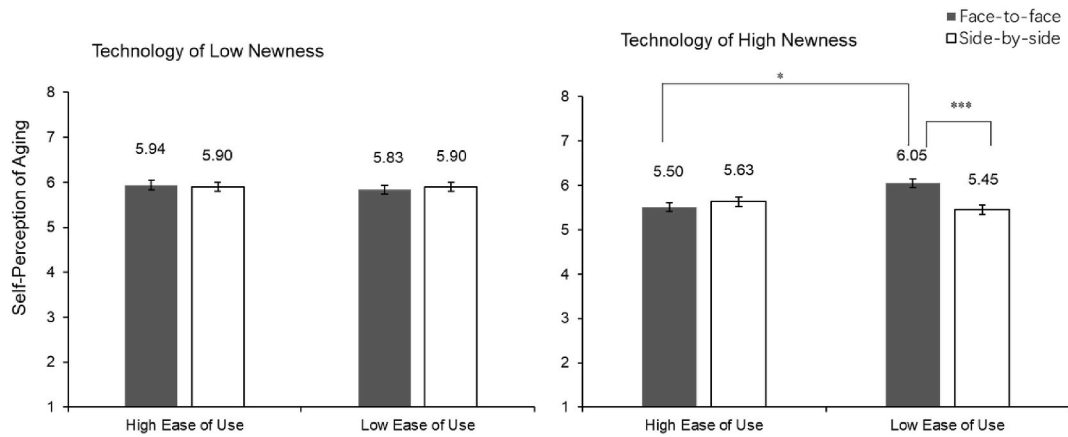
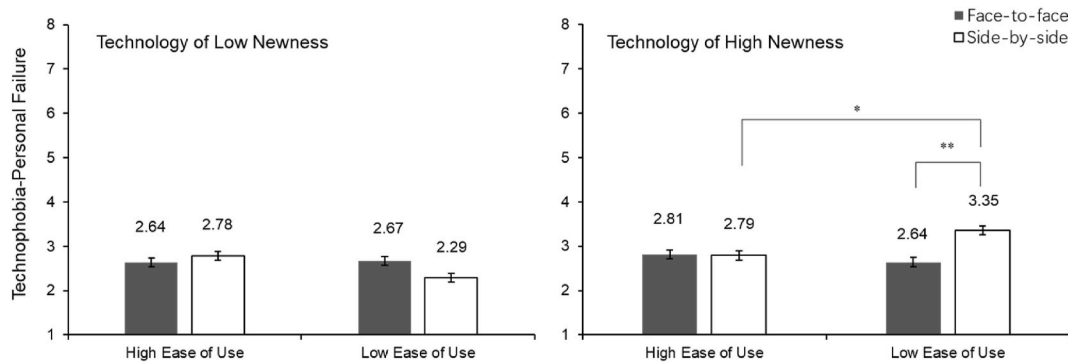
Intergenerational Physical Proximity	Sitting Face-to-Face				Sitting Side-by-Side				F	p
	Low		High		Low		High			
	Ease of use		Ease of use		Ease of use		Ease of use			
	High	Low	High	Low	High	Low	High	Low		
	(n = 31)	(n = 33)	(n = 30)	(n = 29)	(n = 30)	(n = 32)	(n = 30)	(n = 28)		
Age	69.65 (7.79)	67.91 (6.77)	68.30 (6.95)	67.17 (6.14)	65.20 (6.43)	65.41 (6.67)	66.47 (8.37)	67.39 (8.38)	.00	.97
Subjective health	4.52 (1.23)	4.39(1.48)	4.30(1.24)	4.32(1.33)	4.27(0.98)	4.47(1.14)	4.17(1.34)	4.46(1.20)	.01	.95
Subjective socioeconomic status	3.52(1.61)	3.06(1.85)	3.37(1.47)	3.31(1.61)	2.93(1.74)	2.91(1.35)	3.55(1.33)	3.59(1.78)	.16	.69
Technology use experience	3.52(1.61)	3.55(1.52)	3.57(1.65)	3.45(1.40)	4.20(1.06)	3.63(1.68)	4.20(1.45)	4.32(1.25)	1.25	.27

Notes: M = means; SD = standard deviation. Ms are outside parentheses; SDs are inside parentheses.

Table 3

Results of ANOVA and MANOVA analysis.

	Self-Perception of Aging			Technophobia			Human vs. Machine Ambiguity			Convenience		
	F	Sig	Partial Eta Squared	F	Sig	Partial Eta Squared	F	Sig	Partial Eta Squared	F	Sig	Partial Eta Squared
Intergenerational Physical Proximity (IPP)	1.26	.26	.01	.67	.41	.00	3.71	.06	.02	1.54	.22	.01
Technology Ease of Use (TEOU)	.43	.51	.00	.01	.91	.00	1.64	.20	.01	1.00	.32	.00
Technology Newness (TN)	5.71	.02	.02	4.97	.03	.02	2.28	.13	.01	6.56	.01	.03
IPP*TEOU	2.51	.11	.01	.15	.70	.00	0.39	.53	.00	.20	.65	.00
IPP*TN	1.65	.20	.01	2.90	.09	.01	0.06	.80	.00	1.07	.30	.00
TEOU*TN	1.46	.23	.01	2.38	.12	.01	0.75	.39	.00	.26	.61	.00
IPP*TEOU*TN	4.50	.03	.02	5.17	.02	.02	1.18	.28	.01	2.93	.09	.01

**Fig. 2.** Self-perception of aging in the eight conditions. *** $p < 0.001$, * $p < 0.05$.**Fig. 3.** Technophobia-personal failure dimension in the eight conditions. ** $p < 0.01$, * $p < 0.05$.

technophobia-personal failure dimension, we therefore tested the technophobia-personal failure dimension as dependent variables, intergenerational physical proximity as the independent variable, technology ease of use and newness as the moderators and SPA as a mediator.

The intergenerational physical proximity, technology ease of use and newness had a significant interaction effect on technophobia-personal failure dimension ($b = 1.25$, $t = 2.27$, $p < 0.05$). Next, as shown in Table 4, the interaction variable significantly affected self-perception of aging ($b = -0.84$, $t = -2.12$, $p < 0.05$). Therefore, we moderated the first stage of the mediation model by two technology features. However, the two-way interaction effects of intergenerational physical proximity \times ease of use and intergenerational physical proximity \times newness were insignificant ($p.s. > 0.05$). We then controlled for the interaction variables wherein self-perception of aging significantly affects

technophobia-personal failure dimension ($b = -0.43$, $t = -4.99$, $p = 0.00$). However, when controlled for self-perception of aging, the direct effect of the interaction variables on technophobia was no longer significant ($b = 0.89$, $t = 1.68$, $p > 0.05$).

Finally, we conducted a 95% bias-corrected bootstrap analysis (5000 samples). The results reveal that the indirect effect of the interaction between intergenerational physical proximity, technology ease of use and newness on technophobia-personal failure dimension through SPA was significant (effect = 0.16, SE = 0.07, 95%CI = [0.04, 0.32]). However, the indirect effect through SPA was significant only when the technology is of high newness and low ease of use (effect = 0.26, SE = 0.10, 95%CI = [0.09, 0.48]) (see Table 5). Thus, H2, H3 and H6 were supported, such that technology newness moderated the moderating effect of technology ease of use on the mediating relationship between intergenerational physical proximity and technophobia via self-

Table 4

Regression analysis on self-perception of aging and technophobia-personal failure.

Dependent Variable	Self-Perception of Aging	Technophobia-Personal Failure
Constant	5.94*** (.14)	5.19 (.54)
Intergenerational Physical Proximity (IPP)	-.04 (.20)	.12 (.26)
Technology Ease of Use (TEOU)	-.11 (.19)	-.01 (.25)
IPP*TEOU	.11 (.27)	-.47 (.36)
Technology Newness (TN)	-.44* (.20)	-.02 (.26)
IPP*TN	.17 (.28)	-.09 (.37)
TEOU*TN	.66* (.28)	.08 (.37)
IPP*TEOU*TN	-.84* (.40)	.89 (.53)
Self-Perception of Aging		-.43*** (.09)
R ²	.07	.15
F	2.42*	5.29***
df model	7	8
df residual	235	234

Notes: Coding for technology ease of use: high = 0, low = 1; coding for technology newness: low = 0, high = 1. Unstandardized coefficients are outside parentheses, standard errors are inside parentheses.

Table 5

Results of total, conditional direct and indirect effect analysis.

	Moderators		Effect	SE	LL95% CI	UL95% CI
	Newness	Ease of Use				
Total Effect of IPP*TEOU*TN→TPF	–	–	.70	.21	.27	1.12
Conditional Direct effects of IPP→TPF	0	0	.12	.26	-.39	.64
	1	0	.04	.26	-.48	.55
	1	1	.45	.27	-.09	.99
Conditional Indirect effects of IPP → SPA→TPF	0	0	.02	.09	-.15	.23
	0	1	-.03	.08	-.19	.12
	1	0	-.06	.09	-.24	.13
	1	1	.26	.10	.09	.48

Notes: Intergenerational physical proximity (IPP), technology ease of use (TEOU), technology newness (TN), technophobia-personal failure dimension (TPF), self-perception of aging (SPA). Coding for technology ease of use: high = 0, low = 1; coding for technology newness: low = 0, high = 1.

perception of aging among older adults. However, H4 and H5 were not supported, which implies that technology newness or technology ease of use will not moderate the mediation effect independently.

5. General discussion

Considering the pervasive technophobia among older adults and daily situations of intergenerational contact for new technology introduction and learning, this study investigated conditions in which intergenerational contact can be effective in overcoming technophobia by reducing age-based stereotype threat among older adults. By conducting a vignette experiment, we manipulated intergenerational physical proximity to explore two specific types of intergenerational contact: intergenerational contact with close physical proximity, which was represented as sitting side-by-side, and intergenerational contact with more distant physical proximity, which was represented as sitting face-to-face. We also tested the effects of two attributes of technology—newness and ease of use—to examine the interaction effects of the three factors on age-based stereotype threat and technophobia among older adults. The results of the experiment provide several key findings and address research gaps in the literature not only on technophobia, but also on intergenerational contact and age-based stereotype threat.

5.1. The three-way interaction effect of intergenerational physical proximity, technology newness and ease of use on self-perception of aging and technophobia

Firstly, the results of our study reveal a significant three-way interaction effect of intergenerational physical proximity, technology newness and ease of use on age-based stereotype threat among older adults, which was manifested on their self-perception of aging. However, no significant two-way interaction effects were found. This demonstrates that the three factors would jointly influence older adults during the intergenerational contact-based technology learning. Specifically, the effect of intergenerational physical proximity on self-perception of aging was only significant in high technology newness and low technology ease of use, and not in the other conditions. This implies that when older adults are under high threats, the way the two generations interact impact older adults. However, older adults are less likely to be affected by intergenerational contact in the situations when the technology is perceived to be easier to use either with high newness, or merely perceived to be less new (regardless of complexity of use). Based on stereotype threat theory, this may be because such situations would not be perceived as diagnostic enough of technology competence by older adults, which do not evoke age-based stereotype threat among them (Spencer & Steele, 1999; Wheeler & Petty, 2001).

The findings regarding the main effects of technology newness and ease of use on SPA may strengthen this explanation. We found that technology newness alone significantly affects self-perceptions of aging, so that high newness compared with low newness led to significantly more negative SPA among older adults. However, we found no significant main effect for ease of use nor two-way interaction effect between technology newness and ease of use. These findings do not only demonstrate that high technology newness imposed higher threat on older adults, but also imply that compared with technology's ease of use, technology newness serves as a more vital factor in structuring the boundary condition of age-based stereotype threat among older adults. Our other research further revealed that compared with the technologies of low newness, which is framed as a connection to older technology, technologies of high newness, which is framed as a contrast from older technology, would induce higher age-based stereotype threat (Xi et al., 2021).

Secondly, our research explored different dimensions of technophobia and found that, like the results of self-perceptions of aging, technology of high newness compared with low newness led to significantly higher technophobia-personal failure dimension. In addition, the three-way interaction effect between intergenerational physical proximity, technology ease of use and newness was significant only in the dimension of fear of personal failure, rather than human vs. machine ambiguity-dimension or convenience dimension among older adults.

The different results on each dimension of technophobia may be because negative stereotypes often challenge the competence of the stereotyped group. Stereotype threat has consistently been found to arouse various negative perceptions towards oneself, such as frustration (Steele & Aronson, 1995), lack of confidence (Aronson, Lustina, Good, & Keough, 1999) and low self-efficacy (Bandura, 1977). Therefore, it can be argued that age-based stereotype threat among older adults directly affects their fear of personal failure in technology use, which is related to personal competence, rather than fear of negative societal consequences, namely, human vs. machine-ambiguity. Stereotype threat often causes negative rather than positive consequences (Wheeler & Petty, 2001). Age-based stereotype threat affected by intergenerational physical proximity is thus probably more likely to affect negative aspects of technophobia (i.e., personal failure) than its positive aspects (i.e., perceived convenience) (Laidlaw, Power, Schmidt, & Group, 2007).

5.2. The positive effect of more distant intergenerational physical proximity under a high threat condition

The most important and striking finding of our research concerns the optimal intergenerational contact in reducing technophobia via reduced age-based stereotype threat among older adults. Allport (1954) proposed that for intergroup contact to be effective in reducing intergroup bias and the negative impact of stereotype threat, it should be positive and include four optimal conditions: equal status between groups, working towards a common aim or goal, opportunity for intergroup co-operation and institutional support. Such strategies apply to intergenerational contact as well (Dovidio, Glick, & Rudman, 2008; Pettigrew & Tropp, 2006). Sitting side-by-side (vs. face-to-face) creates closer physical proximity and a sense of more equal position between the interacting individuals, which should promote a more positive interpersonal contact experience (Xiao et al., 2016). Our manipulation checks also found that older adults perceived the picture of two people of different generations sitting side-by-side to be more positive than that of the two people sitting face-to-face.

However, we found the opposite effect in the formal experiment in which information related to technology attributes was given to older adults. In this instance, the older adults considered sitting face-to-face (vs. sitting side-by-side) to be a more effective type of intergenerational contact under the condition of high technology newness and low ease of use, because it aroused less age-based stereotype threat in older adults, which manifested as less negative self-perceptions of aging. At first glance, it seemed to contradict our intuition that closer contact is necessarily positive and that therefore it should lead to reduced technophobia. However, as suggested by Xiao et al. (2016), because people tend to physically distance themselves from potential threats or from a threatening out-group to feel safer or more comfortable, the older adults in our study might have found a less physically close interaction safer and more comfortable in conditions that felt more threatening (e.g., where the technology was perceived as having high newness and low ease of use). These results should be interpreted with caution, because in our manipulation of intergenerational contact, the older adults were only primed with a general interaction with younger adults. Details about the communication between the older and young adults were not available. It might be difficult for older adults to span intergroup boundaries as a way to decrease negative self-identity (Stathi & Crisp, 2008).

One may still argue other potential alternatives. For instance, sitting face-to-face across a table may functionally be more ideal for instruction-and-learning, as the target of the instruction-and learning (i. e., technology product) may be physically at the centre, and people are simply more used to this seating arrangement in such situation (Becker et al., 1983; Xiao et al., 2016). Therefore, seating across the table might bring a more positive effect when demonstrating or discussing a new technology. However, we argue that if this is the case, the moderating effect of technology ease of use and newness should not be significant. Thus, such alternatives failed to explain the difference of self-perception of aging and technophobia among older adults between low threat and high threat conditions. Meanwhile, we found that older adults preferred sitting side-by-side in the manipulation check.

5.3. The moderated mediation effect of self-perceptions of aging

Lastly, the moderated mediation effect analysis revealed that, during the intergenerational contact-based technology learning, where the technology is perceived to be highly new and less easy to use among older adults, less intergenerational physical proximity induced more positive self-perceptions of aging, which further helped reduce the fear of personal failure in technology use. This underlying process also provided effective illustration of why the technophobia-personal failure dimension rather than the other two dimensions were affected in the intergenerational contact-based technology learning.

5.4. Theoretical and practical implications

Firstly, previous technophobia research that focused on older adults paid limited attention to the influence of social factors, our research extends the research stream of technophobia by exploring how the social factor of age-based stereotype threat influences technophobia in the context of intergenerational contact-based technology learning. Previous research has explored technophobia mainly on the basis of self-reported survey or intervention studies, which measured a trait-like anxiety that was often shaped by social norms (Khasawneh, 2018a; Martínez-Córcoles et al., 2017; Nimrod, 2018). Contrastingly, we explored technophobia in an experimental manipulation, which should reflect a transitory anxiety and revealed how technophobia can be affected by instant social cues (Goetz, Bieg, Ludtke, Pekrun, & Hall, 2013). Moreover, previous studies of technophobia among older adults have viewed technophobia as a unidimensional variable, without distinguishing between different aspects of technophobia among older adults (Xi et al., 2021). The current study revealed differences in various aspects of technophobia, therefore deepening the understanding of technophobia among older adults.

Secondly, our research findings also contribute to the literature on intergenerational contact and age-based stereotype threat. Many studies that examined the effect of intergenerational contact on age-based stereotype threat reduction had explored the effect of positive intergenerational contact by measuring subjective perceptions of intergenerational contact pleasantness and intergenerational contact amount and frequency, but failed to explore specific ways in which intergenerational contact can be effective (Abrams et al., 2006, 2008). Our research not only focused on interpersonal physical proximity that often structures intergenerational contact, but also explored technology attributes that serve as vital contextual cues in the situation of intergenerational contact-based technology learning, which can effectively bridge the gap in the literature of intergenerational contact and extend the literature on age-stereotype into the domain of technology.

The findings of this research have important implications to design interventions and technology training programs that aims to reduce technophobia among older adults through effective intergenerational contact when introducing new technologies. Firstly, based on our finding that a major source of age-based stereotype threat is the high newness of technology, how to frame technology newness when introducing the technology to older adults must be considered. As suggested by previous research, connecting the new technology with prior knowledge can enhance consumers' positive attitude (Moreau et al., 2001), which may be even more important for older adults. Secondly, our research suggests that instead of emphasizing closeness during intergenerational contact, allowing more private space for older adults may help reduce the risk of age-based stereotype threat and technophobia among older adults. However, for technologies that are familiar to older adults or easy to use, intergenerational physical proximity would not affect their attitudes towards the technology. This specific strategy of intergenerational contact can also be used for marketing, such as introducing new technologies for older consumers through face-to-face interaction with younger salespersons and through advertising persuasion, which includes the portrayal of intergenerational contact.

5.5. Limitations and future research

Our research has several limitations. Firstly, we investigated different types of intergenerational contact by priming the perception of intergenerational physical proximity using pictures. However, we were not able to control how older participants mentally perceived other details of the intergenerational contact during the experiment, such as the type and extent of the conversation (Abrams et al., 2008). It might be useful for future research to investigate intergenerational physical proximity in a real-world setting rather than through participants

looking at pictures.

Secondly, the sample was recruited through one nursing home and one retirement community, which limits the generalizability of the findings. Thirdly, we measured several scales through the self-reports, which might be cognitively over-loaded for many older participants. This may further impede the quality of the data. Future research should explore other methods, such as interview, to measure older adults' psychological reaction to the experimental stimuli.

Lastly, there might be other factors beyond those investigated in this research that induce age-based stereotype threat and affect technophobia among older adults. For example, the effect of intergenerational physical proximity on stereotype threat might be affected by the nature of the intergenerational relationship—say, whether the younger adult is an acquaintance of (e.g. family member, friend) or a stranger to the older adult (Fingerman, Hay, & Birditt, 2004). Meanwhile, because older adults tend to have more negative attitudes than younger people towards technology that does not address the prevailing needs of the older age group, the type of technology might also matter (Hauk et al., 2018). Therefore, further research can consider other contextually related factors in the intergenerational contact and technology-related factors that may affect technophobia among older adults.

Credit author statement

Wanyu Xi: Conceptualization, Methodology, Formal analysis, Writing- Original draft preparation. Xin Zhang and Liat Ayalon: Supervision, Writing- Review & Editing.

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Appendix A. Supplementary data

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