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Age Differences in Responses to Progressive Social Exclusion: The Role of Cognition and Socioemotional Functioning

Corinna E. Löckenhoff,[1] Margaret A. Cook,[2] Jason F. Anderson,[1] and Vivian Zayas[3]

[1]Department of Human Development, [2]Department of Nutritional Sciences, and [3]Department of Psychology, Cornell University, Ithaca, New York.

Jason Anderson is now at the Department of Psychology, Stanford University.

Objectives. In prior research, older adults were found to be less responsive to social slights than younger adults, but the mechanisms behind such effects have remained unclear. The present study examined age differences in susceptibility to the deleterious effects of social exclusion and investigated the explanatory role of cognitive and socioemotional variables.

Method. Forty younger adults (aged 22–39) and 40 older adults (aged 58–89) played a modified version of "Cyberball," a virtual ball-tossing game, in which they were initially included by 2 other players and progressively excluded in subsequent rounds. After each round, participants reported their emotions and needs satisfaction.

Results. Older adults were less likely than younger adults to respond to mild levels of social exclusion, but both age groups responded similarly to more pronounced exclusion. Within the older group, participants with lower cognitive functioning were less responsive to mild exclusion, but this effect did not reach significance in the younger group.

Discussion. Future research on age differences in responses to social exclusion should further explore the role of cognition and examine possible implications for interpersonal functioning.

Key Words: Aging—Cyberball—Social exclusion—Social ostracism.

SOCIAL contacts are generally beneficial for well being, but interactions entailing ostracism, the experience of being disregarded, excluded, or rejected by others (Williams & Zadro, 2001), can leave people feeling worse off. As a species, humans depend on social bonds for their survival, and the severance of such bonds threatens fundamental needs and elicits powerful emotional responses (for a review see Gerber & Wheeler, 2009).

The detrimental consequences of ostracism have been well documented in student samples (see meta-analysis by Gerber & Wheeler, 2009). However, social integration matters for well being throughout the life span, as illustrated by the dire health consequences of social isolation in late life (Shankar, McMunn, Banks, & Steptoe, 2011). Little is known about possible age-related shifts in responses to ostracism. A better understanding of such developmental differences could facilitate the design of appropriate interventions. To this end, the present study examined age differences in susceptibility to social exclusion and explored a range of theoretically implicated mechanisms that might account for the observed age effects.

Since the late 1960's, when a sense of belonging was first identified as a fundamental need (Bowlby, 1969), social scientists have documented a variety of detrimental effects of social exclusion ranging from negative affect (Baumeister & Leary, 1995) and reduced cognitive speed and accuracy (Baumeister, Twenge, & Nuss, 2002) to the experience of physical pain (Eisenberger, Jarcho, Lieberman, & Naliboff, 2006) and even suicide attempts (Williams & Zadro, 2001). It has been suggested that because of the importance of social ties to human survival, responses to the social threat of ostracism are subject to the same evolutionary "hard wiring" as responses to physical threats (MacDonald & Leary, 2005). As such, even minimal cues of exclusion, including those that are abstract and do not require in-person contact, may lead to negative consequences. A broad body of studies have shown that exclusion in the context of "Cyberball," a virtual ball-tossing game in which one person is excluded from the game by the other players, results in significantly lowered self-esteem and feelings of belonging (Gerber & Wheeler, 2009; Williams, Cheung, & Choi, 2000). Moreover, the negative cognitive and affective responses triggered by social exclusion occur even if the exclusion can be attributed to external causes (e.g., computer malfunction; Williams & Zadro, 2001), and if participants are told that they are interacting with a preprogrammed avatar (Zadro, Williams, & Richardson, 2004) or with members of a despised out-group (Gonsalkorale & Williams, 2007).

The effects of social exclusion are very robust in younger adults (Gerber & Wheeler, 2009), but there is some evidence that responses may be less pronounced in middle and late adulthood. In general, aging is associated with a lower frequency of negative social interactions and less intense affective responses if social conflict does occur (for a

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review see Charles & Carstensen, 2010). In part, older adults appear to actively avoid conflict situations. For example, when faced with problem-solving scenarios involving emotionally charged interpersonal situations, older adults are more likely to regulate their own emotions and "let it pass" whereas younger adults are more likely to engage in active problem solving (Blanchard-Fields, Jahnke, & Camp, 1995). When conflict is unavoidable, such as when discussing a topic of disagreement (Carstensen, Gottman, & Levenson, 1995) or working on a conflict-prone collaborative task (Lefkowitz & Fingerman, 2003), older adults consistently report less negative affect than their younger counterparts.

To date, only two studies have directly examined age differences in responses to social rejection and exclusion. Charles and Carstensen (2008) asked younger and older adults to listen to audiotapes in which they ostensibly overheard others making negative comments about them (e.g., regarding their sense of style, trustworthiness, or self-control). After each tape, participants rated their emotions and shared their current thoughts in a talk-aloud procedure. Compared with younger adults, older adults voiced less negative thoughts and reported lower levels of anger in response to social rejection (Charles & Carstensen, 2008). While Charles and Carstensen examined the role of age in responses to negative social stimuli, Hawkley, Williams, and Cacioppo (2011) examined age differences in responses to outright ostracism. In an adapted version of the Cyberball online ball game (Williams et al., 2000), participants were asked to play a virtual game of toss in which they were passing a ball with two other players represented as icons on the screen. Participants either received the ball 5 out of 15 times (inclusion condition) or 2 out of 15 times (exclusion condition). Across two studies (one involving an adult life span sample, the other contrasting middle aged and older adults), the impact of ostracism on needs satisfaction and emotional well being was significantly diminished with age. Taken together, these studies concur that compared with younger adults, older adults are less likely to report negative responses to social rejection and exclusion.

The pattern of age differences in social exclusion raises important questions about the scope and the underlying mechanisms of such effects. For one, given the adaptive advantages of swiftly detecting and responding to social exclusion (MacDonald & Leary, 2005), it is important to understand the degree to which sensitivity to social exclusion is diminished in advanced age. Although reduced emotional responses to mild ostracism may benefit overall emotional well being, failing to respond to severe exclusion may impair an individual's ability to function in group settings. It is also important to gain a better understanding of the mechanisms that drive age effects in responses to ostracism. Although Hawkley and colleagues (2011) examined a wide range of possible psychological mechanisms and social factors (including computer use, autonomic reactivity, pain levels, and life events), none of them could fully account for the observed age effects.

Several theoretical perspectives offer possible explanations for age differences in responses to exclusion. First, age decrements in cognitive resources (Salthouse, 1996) and age-related limitations in the complexity of emotional experiences, and the ability to process mixed emotions (Labouvie-Vief, 2003; Labouvie-Vief, Grühn, & Studer, 2010) may result in overly positive interpretations of social situations and limit older adults' ability to detect subtle social cues (Ruffman, Henry, Livingstone, & Phillips, 2008). If this is the case, one would expect that older adults are less likely to respond to mild forms of social exclusion. However, once exclusion is more pronounced and thus more easily detected, one would expect to find similar deleterious effects regardless of age. Thus, if age-related cognitive decrements play a role, statistically controlling for age differences in fluid cognitive abilities should account for at least some of the variance in responses to ostracism.

An alternative explanation draws on socioemotional selectivity theory (Carstensen, 2006), a life span theory of motivation which proposes that age-related limitations in future time perspective activate short-term goals aimed at emotional well-being in the present moment over long-term goals aimed at information acquisition and future planning. In prior work, these age-related goal shifts were shown to manifest themselves in the selective allocation of cognitive resources toward positive and away from negative information (Mather & Carstensen, 2005), a phenomenon also known as the "age-related positivity effect." In the context of social exclusion, the age-related positivity effect may manifest itself as reduced attention and sensitivity for indicators of social exclusion. If this explanation is correct, one would expect that future time perspective and self-reported sensitivity to social rejection contribute to age differences in responses to social exclusion.

Age groups also differ in social networks and interpersonal preferences. Although younger adults have large social networks that include many distant acquaintances, older adults have smaller networks composed of a greater proportion of close social partners (Lang & Carstensen, 2002). Also, when given the choice, older adults prefer time with familiar social partners over the opportunity to encounter novel social partners whereas younger adults do not show a strong preference for familiar partners (Fung, Carstensen, & Lutz, 1999). Socioemotional selectivity theory explains these effects as the results of age-related motivational changes that prioritize emotionally rewarding interactions with close friends and family over potentially stressful interactions with less familiar others (Lang & Carstensen, 2002). In some of the prior work, older adults may simply not have cared enough about the perpetrators of social rejection (i.e., hypothetical social partners or complete strangers; Charles & Carstensen, 2008; Hawkley et al., 2011) to be hurt by their alleged actions. Consistent with this notion, Cheng, Li, Leung, and Chan, 2011 found

that interactions with close kin were more relevant for older adults' well being than interactions with nonkin. From this perspective, one would expect that age differences in responses to social exclusion are related so social preferences that favor familiar over novel partners.

Following the considerations outlined above, the present study was designed to examine age differences in susceptibility to social exclusion and to explore hypotheses about potential mechanisms. We used the well-known Cyberball paradigm (Williams et al., 2000) to elicit responses to social exclusion. However, in a departure from past work that focused on simple contrasts between inclusion and exclusion (e.g., Hawkley et al., 2011), we implemented a recently developed progressive exclusion paradigm (Anderson & Zayas, 2012). In this task, participants are fully included in an initial round in which they receive the ball from the two other players an equal number of times (33%). In each subsequent round, however, they receive the ball slightly fewer times than in the previous round. Anderson and Zayas (2012) showed among a sample of college students that individuals' sense of belonging and mood was highly sensitive to subtle cues of exclusion. Even a 7% decrease in received ball tosses resulted in robust deleterious effects. In subsequent rounds, degree of exclusion and decrements in well being were associated in a linear fashion. Thus, the progressive exclusion paradigm allowed us to examine whether age differences depend on the severity of experienced ostracism. This is important because previous research indicates that age groups may not only differ in mean responses to social slights but also in the time course of such responses (Charles & Carstensen, 2008).

Given the aforementioned theoretical explanations for age differences in responses to social exclusion, we assessed a range of explanatory covariates. To examine the role of cognitive decrements, we measured participants' awareness of the degree of exclusion and included measures of fluid cognition. To explore the role of socioemotional functioning, we assessed social network characteristics, participants' habitual preferences for close over novel social partners, attachment patterns, and perceived closeness to the other players in the game. To account for age differences in susceptibility to negative social cues, we included a questionnaire measure of rejection sensitivity. Further, because socioemotional selectivity theory postulates time perspective as the driving factor behind age differences in positivity and socioemotional functioning (Carstensen, 2006), we included a measure of future time perspective. To address other possible sources of age-related variance, we also statistically controlled for age differences in five-factor personality traits as well as subjective health and demographics. Finally, to account for the possibility that the Cyberball task may be less familiar or compelling for older as compared with younger adults, we assessed computer use and controlled for suspicion about deception.

Methods

Participants

Eighty-four participants were recruited from the local community through print and online advertisements. Through selective recruitment, younger and older participants were stratified by age, gender, race (White vs. non-White), and education (rated on a scale from 1 = *did not complete High School* to 8 = *graduate/professional degree*). Because our goal was to recruit homogenous samples of community-dwelling participants, undergraduate students were not included. After excluding four participants because of missing data (due to experimenter error or computer malfunction), the sample consisted of 40 younger participants (aged 22–39) and 40 older participants (aged 58–89). Demographics, background variables, and covariates for each age group are shown in Table 1.

Progressive Exclusion Cyberball Paradigm

We used an adapted version of the original Cyberball paradigm, which involves a computerized ball-tossing game (Williams et al., 2000). As in prior work (e.g., Williams et al., 2000; Hawkley et al., 2011), participants were told that they would be playing an online game with other research participants connected via the local campus and other universities. In reality, the other players were simulated by a computer.

As discussed earlier, the effects of ostracism also do not depend on the believability of the source of exclusion (Chernyak & Zayas, 2010). Nonetheless, to make the game more engaging and convincing, bogus messages about signal strength and number of current users appeared on the screen upon login. Further, when explaining the game, experimenters commented on possible delays due to a weak Internet connection.

Figure 1 shows a screenshot of the game from the participant's perspective. When the ball was above the word "You" (as seen in the figure), participants were instructed to click on the silhouette of the player to whom they wanted to toss the ball. There were 5 rounds of Cyberball with 27 tosses in each round. After each round, participants completed a series of questions assessing needs satisfaction and emotional state (see following for further details on this measure).

As explained earlier, we used a progressive exclusion paradigm developed by Anderson and Zayas (2012). All participants received nine tosses in the initial round (33% of tosses = *no exclusion*), followed by seven tosses in the second round (26% of tosses), five tosses in the third round (18.5%), three tosses in the fourth round (10%), and only a single toss in the fifth round (4%).

Measures

Need satisfaction and emotions.—After each round of Cyberball, participants' current level of needs satisfaction

Table 1. Participant Demographics and Background Variables by Age Group

	Young	Old	$p_{young–old}$
Demographics			
Age	27.98 (4.59)	71.38 (8.65)	<.001
Gender (% female)	73%	73%	1
Race (% White)	83%	93%	.18
Education	5.38 (1.58)	5.30 (2.30)	.87
Computer use (hours/day)	3.86 (2.32)	2.50 (1.98)	<.01
Subjective Health	3.80 (.82)	3.70 (.94)	.61
Future Time Perspective (FTP)	53.68 (10.38)	39.63 (13.42)	<.001
Preference for close partners	0.93 (.62)	1.28 (.75)	<.05
Social network characteristics			
Total size	24.05 (11.10)	22.90 (13.67)	.68
Inner circle/total ratio	.28 (.13)	.33 (.16)	.13
Attachment (ECR-SF)			
Avoidance	17.55 (6.29)	17.65 (6.85)	.95
Anxiety	19.90 (6.86)	15.45 (6.13)	<.01
Rejection Sensitivity (ARSQ)	88.53 (42.58)	69.10 (36.85)	<.05
Personality traits (BFI-10)			
Neuroticism	6.08 (1.85)	5.18 (1.80)	<.05
Extraversion	6.43 (1.68)	6.88 (1.80)	.25
Openness	8.60 (1.32)	7.75 (2.04)	<.05
Agreeableness	6.13 (1.36)	7.40 (1.68)	<.001
Conscientiousness	7.65 (1.25)	8.20 (1.45)	.07
Cognitive functioning			
Digit symbol	69.68 (10.87)	48.00 (9.65)	<.001
N-back	.89 (.10)	.70 (.22)	<.001

Notes. For continuous measures, standard deviations are shown in parentheses. Higher scores on cognitive measures indicate better functioning. *ECR-SF* = Experience in Close Relationships Scale; *ARSQ* = Adult Rejection Sensitivity Questionnaire; *BFI-10* = Big Five Inventory.

and emotional state was assessed using 12 pairs of adjectives based on Anderson and Zayas (2012). At the top of the computer screen, participants were presented with the prompt "At this moment I feel . . .". They were then presented with a pair of bipolar items and asked to indicate their current state on a 9-point Likert-type response scale. Needs satisfaction was assessed with regard to belonging (disconnected vs. connected, don't belong vs. belong, like an outsider vs. like an insider) and with regard to control (powerless vs. powerful, I lack control vs. I have control, uninfluential vs. influential), and current emotions were assessed with regard to mood (sad vs. happy, unfriendly vs. friendly, angry vs. pleasant) and comfort levels (uneasy vs. easy, uncomfortable vs. comfortable, awkward vs. not awkward).

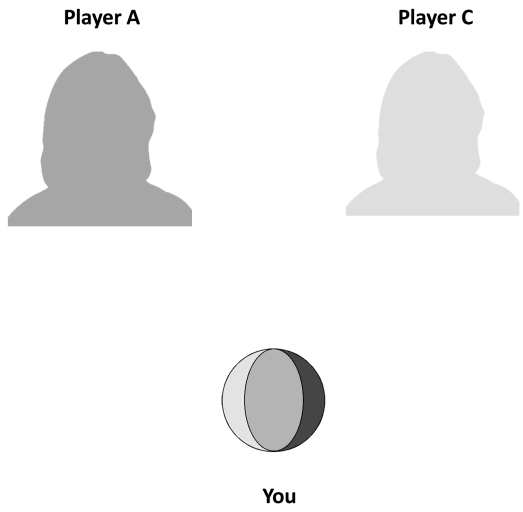

Figure 1. Screenshot of the Cyberball task.

Items were presented in random order, and, to address concerns about acquiescence, half of the scales were reversed. Items were strongly intercorrelated (all rs > .5, p < .001), and preliminary analyses indicated that patterns of results did not differ across needs and emotions. We therefore computed a single composite score for each round, such that higher scores reflected higher well being (in any given round, Cronbach's alpha > .93).

Manipulation checks and suspicion probe.—After the final round of exclusion, participants were questioned to determine if they were aware of their exclusion. Specifically, we asked them to estimate the percentage of time they had passed the ball to Player A and C, as well as the percentage of time the other two players had passed to them.

To account for the possibility that age groups differed in perceived closeness to the other players, we administered the Inclusion of Other in the Self Scale (Aron, Aron, & Smollan, 1992) consisting of a set of 7 increasingly overlapping circles labeled "self" and "other." Participants were instructed to choose the picture that best indicated their current relationship with each of the other players. For further analyses, scores were averaged across players.

At the end of the study, we assessed participants' suspicion about the identity of the players with an open-ended

question: "Did you notice anything odd or unusual about this study?"

Computer use.—Hours of daily computer use were assessed with a single open-ended question.

Subjective health.—Subjective health was assessed with a single item (drawn from Ware, Kosinski, & Keller, 1996) that required participants to rate their general health on 5-point Likert scale.

Personality traits.—Five-factor personality traits were assessed with a short version of the Big Five Inventory (BFI-10, Rammstedt & John, 2007).

Cognitive function.—The Digit-Symbol subtest from the Wechsler Adult Intelligence Scale (Wechsler, 1981) primarily assesses *perceptual and motor speed* but also requires visual scanning and incidental memory. A two-back version of the letter N-back test (Ragland et al., 2002) was used to assess *working memory*.

Adult attachment.—Adult attachment was measured via a short form of the Experience in Close Relationships Scale (ECR-SF, Wei, Russell, Mallinckrodt, & Vogel, 2007).

Rejection sensitivity.—We measured rejection sensitivity using eight items from the Adult Rejection Sensitivity Questionnaire (ARSQ, Berenson et al., 2009). Items use 6-point Likert scales to assess participants' expectations and rejection concerns when initiating social contact or asking for a favor (a question involving sexual relationships was excluded because of concerns about age variability).

Future time perspective.—Perception of time left in life was measured using Lang and Carstensen's 10-item Future Time Perspective Scale (FTP, Lang & Carstensen, 2002), which assesses perceived limitations in time and future opportunities.

Social preferences.—To measure social preferences, participants were told that they had half an hour of free time to spend with someone else. Two questions (Fung & Carstensen, 2004) each offered choices among a close social partner (e.g., "a member of your immediate family"), a social partner offering the opportunity for future interactions (e.g., "a recent acquaintance with whom you seem to have much in common"), and a social partner offering new information (e.g., "the author of a book you have just read"). For further analyses we computed the number of times (0–2) each participant had chosen the close social partner.

Social network.—Participants were asked to map their social convoy (Antonucci, 2001) on a graph with four concentric circles. The center was labeled "ME." The inner circle was labeled "People you feel very close to," the middle circle was labeled "People you feel close to," and the outer circle was labeled "People whom you feel less close to but who are still important to you." Participants entered the initials of their social partners in the circle corresponding to their relative closeness. For further analyses, we computed both the total size of the network (number of initials in all three circles) and the ratio of individuals in the inner circle versus total social partners.

Procedure

The study took place in private testing rooms at the Cornell university campus. Upon arrival, participants gave written consent. Next, they completed a series of background questionnaires (presented in E-Prime 2.0) assessing demographics and computer use, personality traits, subjective health, attachment, rejection sensitivity, social preferences, and future time perspective. Next, participants completed a social network questionnaire using a paper and pencil format.

After an optional break and a series of unrelated measures, participants then played Cyberball (implemented in Inquisit 3.0.5.1). Before the game began, we assessed feelings of closeness to the other players.

Immediately following each round of Cyberball, participants completed a 12-item emotions and needs assessment. After the fifth round of Cyberball, participants also estimated the percentage of tosses made by themselves and the other players. Before logging off, participants played a final round of Cyberball where they were equally included (one-third of all tosses) to remediate any negative feelings. The study concluded with cognitive measures and the suspicion check. Finally, participants were paid and thoroughly debriefed.

Results

Background Characteristics

As seen in Table 1, age groups did not differ in gender, education, or race, but older adults reported fewer hours of computer use than younger adults. Consistent with the prior literature (Srivastava et al., 2003; Carstensen, 2006), older as compared with younger adults had a more limited time horizon, scored lower in neuroticism and openness to experience, and higher in agreeableness. Also, in line with patterns of cognitive aging (Salthouse, 1996), older adults scored lower than younger adults on measures of perceptual and motor speed (Digit Symbol) and working memory (N-back).

With regard to interpersonal relationships, older adults showed the predicted preference for close social partners and scored lower on measures of attachment anxiety and rejection sensitivity. Age differences in social network characteristics did not reach statistical significance, although, consistent with the literature, we found a trend ($p = .13$) in

the direction of older adults reporting a greater proportion of close (relative to more distant) partners.

Manipulation and Suspicion Checks

To test participants' awareness of social exclusion after the final round of Cyberball, we examined the percentage of times participants thought the other players passed the ball to them as opposed to each other. If participants were unaware of the bias, one would expect them to report that for each throw made by one of the other players, they received the ball 50% of the time. Instead, participants reported that they received the ball only 29% of the time. A one-sample *t* test indicates that this value is significantly below 50%, $t(79) = 12.30$, $p < .001$. This suggests that by the final round of Cyberball, in which they were excluded for all but one of the tosses, participants were well aware of the social exclusion. There were no age differences in awareness of the exclusion, $t(78) = .14$, n.s.

To check for suspicion, we examined the extent to which participants suspected that they were not playing with real humans. In response to the open-ended suspicion probe, only 14% of participants reported any doubt that the ball-game was genuine. Suspicion differed by age in that 10 of the younger adults but only one of the older adults voiced suspicions, ($\chi^2(1, N = 80) = 8.54$, $p < .01$). Preliminary analyses indicated that the pattern of results remained the same if participants with suspicion were excluded. Subsequent analyses were therefore conducted on the full sample.

We also tested for age differences in perceived closeness to the other players and found that older participants reported somewhat greater closeness ($M = 2.19$, standard deviation [*SD*] = 1.50) than younger participants ($M = 1.44$, $SD = .74$, $t(78) = 2.84$, $p < .01$, d = .73). However, preliminary analyses indicated that perceived closeness was not significantly associated with responses to social exclusion ($r < .2$, n.s.). It was therefore dropped from further analyses.

Responses to Progressive Social Exclusion

To examine the influence of age on participants' responses to progressive exclusion, we computed a General Linear Model (GLM) with age (young vs. old) as a between-subjects variable, time of assessment (Time 1 to Time 5) as a within-subject variable and the emotions/needs composite scores as the dependent variable. If applicable, Greenhouse–Geisser corrections were used to account for deviations from sphericity. As shown in Figure 2, this analysis yielded a significant linear effect of assessment time, $F(1.75, 136.43) = 24.67$, $p < .001$, partial $\eta^2 = .24$. Consistent with the findings by Anderson and Zayas (2012), participants showed a linear decline in emotions/needs in response to increasing social exclusion: On average, participants' scores on the 9-point composite scale dropped from 5.82 (standard error [*SE*] = .15) in the initial round of the game to 4.77 (*SE* = .21) the final round.

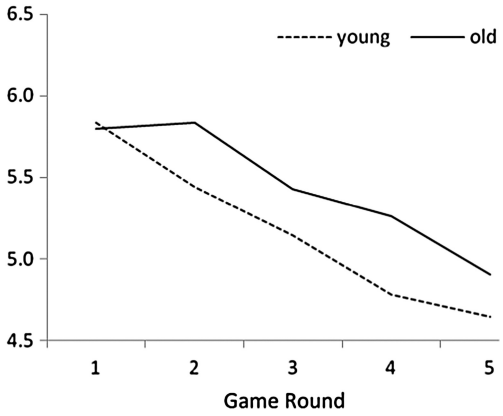

Figure 2. The Effects of age and progressive exclusion on a composite measure of emotional well being and needs satisfaction. Note. Higher scores on the composite measure reflect higher well being (range = 1–10). Game Round 1 = 33% of tosses (full inclusion), Round 2 = 26% of tosses, Round 3 = 18.5% of tosses, Round 4 = 10% of tosses, Round 5 = 4% of tosses.

There was no significant main effect of age ($p = .55$). With regard to the age by time interaction, there was no significant linear effect ($p > .2$) but a significant quadratic effect, $F(1, 78) = 6.23$, $p < .05$, partial $\eta^2 = .07$, and a significant 4th order effect, $F(1, 78) = 5.04$, $p < .05$, partial $\eta^2 = .06$.

To explicate the age group by assessment time interaction, we computed separate GLMs within each age group entering assessment time as a within-subjects factor and the emotions/needs composite scale as the dependent variable. Younger adults showed a significant linear effect of time, $F(1, 39) = 21.63$, $p < .001$, partial $\eta^2 = .36$, but no quadratic or higher order effects (all *p*s > .1). Older adults, in contrast, showed both a linear effect of time, $F(1, 39) = 12.32$, $p < .001$, partial $\eta^2 = .24$, and a quadratic effect of time, $F(1, 39) = 3.92$, $p < .05$, partial $\eta^2 = .09$.

As illustrated in Figure 2, older adults appeared to be less sensitive than younger adults to mild forms of social exclusion. Consistent with the idea that even very subtle cues of exclusion are sufficient to impact well being (Anderson & Zayas, 2012), younger adults' emotions/needs scores showed a significant drop from Round 1 (no exclusion, receiving 33% of all throws) to Round 2 (receiving 26% of all throws, $M_{young} = .40$, $SD = .71$). In contrast, older adults' scores did not drop between Rounds 1 and 2 ($M_{old} = -.03$, $SD = .95$). This age difference in drop rates was statistically significant, ($t(78) = 2.32$, $p < .05$, $d = .51$). When social exclusion became more severe in subsequent rounds, the age effect was no longer visible. From Round 2 to Round 5, the net drop in emotions/needs scores did not differ by age, $M_{young} = .78$, $SD = 1.22$, $M_{old} = .94$, $SD = 1.39$, $t(78) = .52$, $p > .6$, $d = .12$.

The Role of Covariates

To examine the role of covariates, we selectively focused on responses to mild levels of exclusion, which appeared to

be driving the observed age effects. For this purpose, we computed a change score capturing the decrement in composite emotions/needs ratings between the first two rounds (Change score = Round 1 Score − Round 2 Score). The higher this change score, the greater the negative effect of mild social exclusion for a given participant (In preliminary analyses, the pattern of results was equivalent when using residualized change scores derived from a regression of Round 2 on Round 1 scores. For greater ease of interpretation, subsequent analyses report simple change scores).

We then observed the associations between the change score and any of the potential covariates that were found to differ by age (see Table 1). Stronger responses to social exclusion were found among participants who used computers more frequently ($r = .26$, $p < .05$), reported higher sensitivity to rejection (ARSQ, $r = .23$, $p < .05$), and scored higher on perceptual and motor speed (Digit Symbol: $r = .30$, $p < .01$). For all other variables $|r| < .2$, n.s.

Next, we examined if any of these variables could statistically account for the observed age differences in responses to mild ostracism. For this purpose, we conducted a series of regression analyses with the change score as the dependent variable. Age was entered in a first block ($R^2 = .06$, $\beta = -.25$, $p < .05$) and each of the potential covariates was entered in a second block. Entering computer use and rejection sensitivity did not significantly increase the amount of explained variance ($\Delta R^2 < .35$, n.s.). Entering perceptual/motor speed increased the amount of explained variance ($\Delta R^2 = .45$, $p = .05$), revealed a significant effect of perceptual and motor speed on the change score ($\beta = .3$, $p = .05$) and rendered the effect of age no longer statistically significant ($\beta = -.04$, n.s.).

In further analyses, following Hawkley and colleagues (2011), we included the covariates in a GLM with age as a between-subjects factor, assessment time (Round 1 to Round 5) as a within subjects factor, and the composite moods/needs score as the dependent variable. The age by assessment time interactions remained significant when statistically controlling for computer use and rejection sensitivity ($p_{age} < .05$). Again, age effects were no longer significant when controlling for perceptual and motor speed ($p_{age} > .2$).

Taken together, this implicates age differences in processing speed as the most plausible explanation for age differences in responses to social exclusion. However, further analyses revealed that the correlation between perceptual and motor speed and changes scores reached statistical significance in the older group ($r = .32$, $p < .05$) but not in the younger group ($r = .11$, n.s.). Although this difference in correlation coefficients was not significant (Fisher's $z = 1.1$, n.s.), findings need to be interpreted with some caution (see following).

Discussion

The present study adds to the literature by examining age differences in responses to progressive social exclusion and investigating theoretically implicated mechanisms for this effect. Our findings suggest that older adults are less likely than younger adults to respond to mild levels of social exclusion. For more pronounced social exclusion, however, no age differences in responses are found. These results extend the work by Hawkley and colleagues (2011), who found that compared with younger adults, older adults respond less strongly to social exclusion in a short version of the Cyberball paradigm (consisting of a single round of Cyberball with only 15 tosses). We replicated this pattern of age effects with regard to mild social exclusion (Round 2), where younger adults showed a drop in well being relative to the baseline whereas older adults remained stable. In contrast, age differences were absent when social exclusion was prolonged and more pronounced (Rounds 3–5). Understanding the degree to which sensitivity to social exclusion is diminished in advanced age is critical for evaluating potential implications for interpersonal functioning in everyday life.

We also examined a range of conceptually driven covariates that were not considered in prior work (Hawkley et al., 2011). Drawing on the theoretical framework of socioemotional selectivity theory (Carstensen, 2006), we examined if age differences in sensitivity to social exclusion are due to shifts in social goals that lead older adults to prioritize close relationships and show relative indifference toward more distant others in the face of limited time horizons. Our findings do not offer any support for this account. First, although age groups differed in perceived closeness to the other players, perceived closeness was not significantly associated with responses to social exclusion. Also, age differences in responses to social exclusion were not explained by preferences for close social partners, social network characteristics, attachment patterns, or future time perspective. Finally, although we observed familiar patterns of age differences in personality traits, especially with regard to agreeableness, which captures affiliative tendencies (Roberts, Walton, & Viechtbauer, 2006; Terracciano, McCrae, Brant, & Costa, 2005), this did not explain the age effects in responses to social exclusion.

We did find some convergence between susceptibility to the Cyberball paradigm and a self-report measure of rejection sensitivity (ARSQ, Berenson et al., 2009). The two variables were significantly correlated and both showed a significant negative association with age. This could be interpreted as older adults having some insight into their reduced responsiveness to social rejection. Susceptibility to ostracism was also associated with more frequent computer use. Conceivably, younger adults' greater familiarity with online communication may make them more susceptible to social slights in the virtual world. However, neither rejection sensitivity nor computer use could statistically account for the observed age effects.

Among the wide range of covariates under consideration, only participants' scores on Digit Symbol, a measure of

perceptual and motor speed that is strongly affected by age-related slowing (Salthouse, 1996), could statistically account for age differences in response patterns. This finding is consistent with the notion that older adults' reduced processing capacity and limited perceptual abilities make them less likely than their younger counterparts to pick up on subtle cues for social exclusion. Further, our findings converge with research on age decrements in emotion recognition, which have been linked to cognitive deficits as well (Ruffman et al., 2008; Ruffman, Murray, Halberstadt, & Taumoepeau, 2010). However, it is important to note that the association between processing speed and responses to social rejection only reached statistical significance in the older group but not in the younger group. It is possible that the relationship between these variables follows a threshold model such that significant associations are observed at lower levels of processing speed but not above certain threshold. Of course, it is also possible that the mechanisms that drive responses to social rejection differ by age.

To address such questions and further explore the role of cognitive capacity, it is important to disentangle age differences in the cognitive appraisal that social exclusion is occurring from age differences in emotional responses to social exclusion. In the present study, we were concerned about drawing participants' attention to exclusion rates and thus creating demand characteristics. Therefore, we only assessed participants' perceptions of the throwing patterns at the very end of the Cyberball paradigm. At that point, all participants were aware that they had not been fairly included and this insight did not differ by age. Future research should assess perceived exclusion after each individual round to see if age groups differ in their awareness of milder forms of social exclusion. This question is particularly relevant in light of dynamic integration theory (Labouvie-Vief, 2003; Labouvie-Vief, Grühn, & Studer, 2010), which highlights the close linkages between cognitive and emotional processing over the course of development and would predict that age differences in cognitive appraisal and emotional responses to social exclusion follow a similar pattern.

Of course, there are several important limitations that need to be considered when interpreting our results. One concern is the artificial nature of the Cyberball paradigm, which raises questions about suspicion and demand characteristics. Although younger participants reported significantly higher suspicion rates than older adults, excluding suspicious participants did not change the pattern of findings. This is consistent with prior research indicating that even if participants are explicitly told that they are playing with a computer, negative responses to ostracism persist (Zadro et al., 2004). Also note that, if anything, higher suspicion rates among younger adults would have dampened negative responses to rejection and thus worked against the observed age effects.

Another potential concern with the Cyberball paradigm is its minimalist approach to establishing a "social" context. The lack of personal interaction with the other players raises concerns about generalizability. In this regard, it is reassuring to note that our findings converge with those of Charles and Carstensen (2008) who used a richer and more contextualized set of social stimuli. There are also some concerns about the progressive nature of the paradigm. On the one hand, there is no theoretical reason to assume that responses to gradual social exclusion draw on different mechanisms than responses to sudden social exclusion. On the other hand, there was no control group who was not confronted with progressive exclusion, and it is conceivable that successive decrements in well being are partially due to fatigue or boredom after playing multiple rounds of the same game. Contrary to this account, we found that effects were consistent across items assessing emotional responses (which should be more susceptible to fatigue) and items assessing sense of belonging (which should be less susceptible to fatigue). Also, a previous study using the same paradigm (Anderson & Zayas, 2012) contrasted progressive exclusion with progressive overinclusion and found that decrements in emotions and needs fulfillment were specific to the exclusion condition.

Even though the Cyberball paradigm has important limitations, it has been extensively used among younger adults and sparked a series of noteworthy discoveries (for a review see Gerber & Wheeler, 2009). Since the present study is one of the first (after Hawkley et al., 2011) to administer the Cyberball paradigm to older adults, we chose to implement a standard, minimalist version of the task to ensure consistency with previous findings. Nevertheless, future studies should employ more realistic scenarios involving face-to-face interactions with perpetrators of social exclusion to examine the robustness of age effects.

There are also some concerns about sampling. To ensure comparability across age groups, we stratified the groups by demographic characteristics and purposely excluded undergraduate students. However, our sample is not representative of the general population and racial minorities are under-represented. In this respect, it is reassuring that our results for younger adults map well onto previous findings obtained in a racially diverse sample of college students (Anderson & Zayas, 2012). Another sampling concern is the use of a dichotomized age variable. With a mean age of 71 years, our "older" sample was more representative of young–old than old–old adults. Therefore, it is not clear if sensitivity to social exclusion shows linear decrements with age (as indicated in the work by Hawkley et al., 2011) or whether effects emerge with the onset of old age and remain stable thereafter. Finally, like all cross-sectional studies on age differences, the present findings fail to disentangle age and cohort effects. This is a concern because historical changes in social etiquette and display rules may play a role in the observed age differences.

In summary, the present findings add to our understanding of age differences in responses to social exclusion

by suggesting that age groups differ in their susceptibility to progressive exclusion and that age decrements in cognitive resources may play a role. Future studies should further explore this question using representative life span samples and more realistic scenarios. The present findings also raise questions about the practical implications of older adults' reduced sensitivity to social rejection. In particular, future work should weigh potential benefits for well being that stem from overlooking mild ostracism against potential interpersonal problems as a result of a reduced sensitivity to social cues.

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Correspondence

Correspondence should be addressed to Corinna Löckenhoff, PhD, Department of Human Development, MVR Hall, Cornell University, Ithaca, NY 14853. E-mail: CEL72@cornell.edu.

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