

Personality and Social Psychology Bulletin

<http://psp.sagepub.com>

Mental Exercising Through Simple Socializing: Social Interaction Promotes General Cognitive Functioning

Oscar Ybarra, Eugene Burnstein, Piotr Winkielman, Matthew C. Keller, Melvin Manis, Emily Chan and Joel Rodriguez

Pers Soc Psychol Bull 2008; 34; 248

DOI: 10.1177/0146167207310454

The online version of this article can be found at:
<http://psp.sagepub.com/cgi/content/abstract/34/2/248>

Published by:

 SAGE Publications

<http://www.sagepublications.com>

On behalf of:



Society for Personality and Social Psychology, Inc.

Additional services and information for *Personality and Social Psychology Bulletin* can be found at:

Email Alerts: <http://psp.sagepub.com/cgi/alerts>

Subscriptions: <http://psp.sagepub.com/subscriptions>

Reprints: <http://www.sagepub.com/journalsReprints.nav>

Permissions: <http://www.sagepub.com/journalsPermissions.nav>

Citations (this article cites 62 articles hosted on the SAGE Journals Online and HighWire Press platforms):
<http://psp.sagepub.com/cgi/content/refs/34/2/248>

Mental Exercising Through Simple Socializing: Social Interaction Promotes General Cognitive Functioning

Oscar Ybarra

University of Michigan

Eugene Burnstein

University of Michigan, University of Warsaw

Piotr Winkielman

University of California, San Diego

Matthew C. Keller

University of Colorado, Boulder

Melvin Manis

University of Michigan

Emily Chan

Colorado College

Joel Rodriguez

U.S. Federal Bureau of Investigation

Social interaction is a central feature of people's life and engages a variety of cognitive resources. Thus, social interaction should facilitate general cognitive functioning. Previous studies suggest such a link, but they used special populations (e.g., elderly with cognitive impairment), measured social interaction indirectly (e.g., via marital status), and only assessed effects of extended interaction in correlational designs. Here the relation between mental functioning and direct indicators of social interaction was examined in a younger and healthier population. Study 1 using survey methodology found a positive relationship between social interaction, assessed via amount of actual social contact, and cognitive functioning in people from three age groups including younger adults. Study 2 using an experimental design found that a small amount of social interaction (10 min) can facilitate cognitive performance. The findings are discussed in the context of the benefits social relationships have for so many aspects of people's lives.

Keywords: *cognitive performance; socializing; mental exercise; social intelligence; executive function; group living*

Descartes' famous philosophical statement, "Cogito ergo sum" or "I think therefore I am" captures a core aspect of people's identity, which also seems to be reflected in the moniker we have placed on our own species, *Homo sapiens*, the wise or knowing man. It appears that the capacity to cogitate holds a special place in people's lives. From the first weeks of human life parents rush to buy whatever new gadgets will allow their children to blossom mentally. And at the sunset stages of life, older adults scramble doing various brain

Authors' Note: This research was supported in part by a seed grant from the Center for Aging and Cognition: Health, Education, & Training (CACHET) at the Institute for Social Research and National Science Foundation Grant BCS-0217294 to Piotr Winkielman. We thank Amy Kiefer for her help in conducting literature searches, Lynne Schaberg for her assistance with some of the analyses, and Hal Pashler and Tim Rickard for helpful discussions. Correspondence should be addressed to Oscar Ybarra, University of Michigan, Department of Psychology and Research Center for Group Dynamics, 530 Church Street, Ann Arbor, MI 48109-1109; e-mail: oybarra@umich.edu.

PSPB, Vol. 34 No. 2, February 2008 248-259

DOI: 10.1177/0146167207310454

© 2008 by the Society for Personality and Social Psychology, Inc.

teasers to stave off mental decline. In this research we propose that more social factors, like simply engaging in social interaction, can also play a role in helping people stay mentally sharp.

Up until recent history, people's lives have been dominated by being socially connected and having relationships with others (Aries, 1962). In their classic book, Cartwright and Zander (1953) allude to this by referring to an alien who is visiting earth for the first time. They note that the alien would be impressed by the amount of time people spend doing things with others. For example, people tend to gather and live in the same dwellings, satisfy various biological needs within the group, depend on the same economic support, rear children together, and generally care for one another. People's education also tends to occur in groups, and much of the work that occurs in the world is carried out by people performing duties and activities interdependently (Cartwright & Zander, 1953). Human life has traditionally been a socially connected one, possibly one with deep phylogenetic roots (cf. Jolly, 1966).

In more recent times, though, social connections among people seem to be on the decline. As Putnam (2000) has noted in his book, *Bowling Alone*, there has been much loss in social capital in the United States over the last couple of decades. This is evident, for example, in the decline of the number of organizations people are part of and the number of meetings they attend that involve being around others and having face-to-face interaction. There has also been a decline in family dinners and the occasion with which people have friends over for a visit. Other research indicates that people have fewer close others they can talk to about their innermost thoughts and feelings (McPherson, Smith-Lovin, & Brashears, 2006). Our society appears to be in a state of social decline, not one in which the environment is chaotic and people fear for their lives, but one in which people have fewer interactions and relations with others.

Having few social connections has been shown to have important implications for people's health. For example, a preference for being with others is strongly correlated with well-being (Sinha & Verma, 1990; Triandis et al., 1986), whereas people with low social support are more prone to mental illness (McGuire & Raleigh, 1986), depression (Gladstone, Parker, Malhi, & Wilhelm, 2007), and lower immunocompetence (Kiecolt-Glaser, Garner, Speicher, Penn, & Glaser 1984). In addition, socially rejected individuals have been shown to suffer from self-regulation deficits (e.g., Baumeister, DeWall, Ciarocco, & Twenge, 2005). Studies have also shown that fewer social connections are related to the risk of death even after controlling for level of health (House, Landis, & Umberson, 1988).

Social interaction and relationships add to people's quality of life in numerous ways.

But social interaction might be good not only for physical health. In the present research we propose that social interaction can also facilitate cognitive functioning,¹ including long-term and short-term effects on performance. This prediction is grounded in several lines of research.

Research in social cognition has long emphasized that the inferential processes underlying social interaction involve a complex set of computations (Heider, 1958; Mead, 1934). For example, a simple exchange of views between two people requires that they pay attention to each other, maintain in memory the topic of the conversation and respective contributions, adapt to each other's perspective, infer each other's beliefs and desires, assess the situational constraints acting on them at the time, and inhibit irrelevant or inappropriate behavior. Some of these processes are automatic, but others depend on limited-capacity cognitive resources often subsumed by the term *executive functions*, which include capacities such as attention, working memory, and cognitive control (Shallice, 1988; E. E. Smith & Jonides, 1999). For example, a host of social cognition studies has shown that loading working memory can influence many strategic aspects of social inference (Gilbert, Pelham, & Krull, 1988; Trope, 1986).

The involvement of general cognitive capacities in social inference is also documented by social cognitive neuroscience (Lieberman, Gaunt, Gilbert, & Trope, 2002). For example, the understanding of others' beliefs and desires relies on the prefrontal cortex, especially medial and orbitofrontal cortex—regions that are traditionally associated with executive function, especially working memory and attention (e.g., Baron-Cohen & Ring, 1994; Brunet, Sarfati, Hardy-Bayle, & Decety, 2000; Fletcher et al., 1995; Frith & Frith, 1999; Royall et al., 2002; E. E. Smith & Jonides, 1999). Similarly, control over the expression of beliefs and attitudes is subserved by prefrontal and parietal regions, the same regions involved in general cognitive control (Amodio & Frith, 2006; Nielson, Langenecker, & Garavan, 2002). The critical role of these regions in social interaction is illustrated by the profound effects of their damage to social reasoning and behavior (Blumberg et al., 1999; Damasio, 1994; Kling, 1986; Kling & Steklis, 1976; Moll, de Oliveira-Souza, Bramati, & Grafman, 2002; Myers, Swett, & Miller, 1973; Stone, Baron-Cohen, & Knight, 1998). Of course, there is some differentiation of neural mechanisms supporting social and nonsocial cognition, but for the purpose of our argument here, we primarily want to highlight the enormous importance of executive functions for social cognition (Adolphs, 2001).

Given the evidence for the functional and neural overlap between social and general cognitive functioning, there is remarkably little research testing whether social interaction can promote cognitive capacities. One reason for this could be that until recently general cognitive capacities were seen as relatively fixed and not subject to change, at least in nonclinical populations. However, this picture is changing in light of several pieces of evidence. For one, research in cognitive neuroscience has shown that the actual capacity of working memory and attention can increase with training and facilitate performance in novel, unrelated tasks (Olesen, Westerberg, & Klingberg, 2004; Posner & Rothbart, 2005). Importantly, these effects can be observed in typical, as well as clinical, populations and can occur after a few weeks of training, reflecting more permanent effects. These findings are especially relevant to the present Study 1, which explores long-term effects. However, beneficial effects of social interaction on cognitive performance should also be observed with short training episodes, as we examine in Study 2. In this case, the underlying mechanisms are better characterized as “resource priming” or preactivation of general mental operations involved in both social interaction and cognitive tasks. This is analogous to how the activation of more specific procedures and concepts in memory readies semantically related knowledge and behavioral patterns (Anderson, 1993; E. R. Smith, 1994). Such a mechanism presumably underlies transfer benefits across tasks that share little common content but engage the same general cognitive skills, such as working memory and attention (Baddeley, 2002; Singley & Anderson, 1989). In short, the emerging evidence makes it plausible that engaging in social interaction should have beneficial effects on general cognitive skills, even with nonclinical populations, and that these effects should be observed in both the long term and short term.

A Possible Relationship Between Social Interaction and Cognitive Functioning

Some research has considered the relationship between social interaction and cognitive functioning. However, in those studies social interaction is usually not the main focus of the research. Furthermore, many times it is assessed with very indirect social indicators (third-party reports) or it is conflated with a variety of indicators, some of which are poor proxies of actual social contact (e.g., marital status). In addition, this research is restricted to elderly populations and tends to focus on extreme forms of cognitive impairment or even disease rather than the typical range of mental functioning. Nevertheless, available studies are at least suggestive of a relationship between social interaction and cognitive functioning.

For example, investigators found that the risk of developing Alzheimer’s disease was lower for people who were described by an informant as socially active than those described as socially inactive (Kondo & Yamashita, 1990). A recent study has also shown that the risk of developing Alzheimer’s disease was higher for people reporting feeling lonely (Wilson et al., 2007). These findings are additionally buttressed by lab experiments showing that simply imagining that one has been socially rejected negatively affects cognitive performance (Baumeister, Twenge, & Nuss, 2002). Additional studies have also shown that very general indicators of people’s social environment, such as recreational activities, were related to a lower incidence of dementia (Fabrigoule et al., 1995).

Other research has attempted to study more specifically the features of people’s social networks in relation to the development of dementia (Fratiglioni, Wand, Ericsson, Maytan, & Winblad, 2000). In this research the measure of people’s social networks included marital status and whether a person lived with a partner or other persons, number of close social ties (relatives and close friends), frequency of contact with these various parties, and the person’s satisfaction with these contacts. The results indicated that low levels of social engagement were related to an increased risk of developing dementia.

Finally, some research suggests that at least among the elderly, social factors are related to general cognitive functioning and not just extreme impairments. For example, in studies of noninstitutionalized elderly persons and a high-functioning group of elderly participants, researchers found that greater social engagement (e.g., presence of spouse, contact with friends, group memberships) was associated with better cognitive functioning (Bassuk, Glass, & Berkman, 1999; Seeman, Lusignolo, Albert, & Berkman, 2001; see also Arbuckle, Gold, Andres, Schwartzman, & Chaikelson’s, 1992, study on elderly men).

The Present Research

The preceding studies are encouraging and point to a potentially important relationship between social factors and cognitive functioning. However, these studies bring up various issues. As noted earlier, in some of these studies vague activities are taken as indicators of degree of social interaction. In addition, many times a person’s marital status was not controlled for but included as an indicator of degree of social interaction and combined with indicators that varied in specificity (e.g., marital status vs. frequency of contact). Furthermore, the samples were limited to older adults. Finally, no study that we know of has shown that social interaction can

have a direct, causal influence on cognitive performance and that such effects can result from even small amounts of social interaction, a finding with potentially important implications.

In addition to the preceding points, the available research also leaves unclear two critical issues. The first issue is the generality of the social interaction effect. Does social interaction create cognitive benefits only after substantial periods of time, say months, years, or decades, and is this what is being captured with the study of older adults? Or could the positive effects of social interaction be apparent even for people who have undergone little cognitive decline? Furthermore, can such cognitive benefits be visible only after a short social interaction episode? The second critical issue is the causal direction. All the social interaction studies so far have looked at this via correlational measures. This obviously raises the issue of whether social interaction per se promotes cognitive functioning or cognitive functioning promotes interaction.

The present research sought to clarify these issues. As a first step, Study 1 used a survey methodology to examine whether there is a relationship between cognitive functioning and specific measures of social interaction, rather than nonspecific indicators. Furthermore, this study focused on cognitive functioning, not extreme impairment, and whether it relates to social interaction across different age groups, not just older adults. If a relationship exists between social interaction and cognitive functioning across age groups, this would suggest that anyone can stay sharper mentally by engaging in more social interaction, assuming the relationship is causal in nature. Study 2 focused on this latter issue by examining the cognitive effects of social interaction in a group of younger adults. If cognitive benefits occur, this would provide a conservative causal test of the direction of influence from social interaction to better cognitive functioning given that on average younger adults have undergone little cognitive decline (Park, 2000), in addition to showing that small amounts of interaction can have cognitive benefits.

STUDY 1

Method

Study population. The data for Study 1 came from personal interviews from the Survey of Americans' Changing Lives (House, 1986) and consisted of a national, stratified area probability sample (3,610 of 3,617 interviews available for analysis because of missing responses). The age range of the participants was 24–96 years of age. The topics covered in the interviews

included interpersonal relationships, sources of satisfaction, social interactions and leisure activities, illness and traumatic life events, employment and financial status, physical and psychological well-being, cognitive functioning, and other lifestyle and demographic characteristics.

Dependent variables: Cognitive functioning. As part of the interview, the interviewers assessed participants' cognitive functioning using the mini-mental exam (Folstein, Folstein, & McHugh, 1975). The measure deals with participants' knowledge of personal information (e.g., mother's maiden name) and current events (e.g., "Who is the president of the United States?"; range of scores = 0–7). The mini-mental exam also includes a simple test of working memory, in which participants are given a number (i.e., 20) and asked to subtract 3, and to keep subtracting 3 from each new number they get. Performance consists of the number of times participants are able to count backward by three (range of scores = 0–6). Total cognitive performance was computed by adding the score on the general knowledge questions to the score on the memory test, with higher scores indicating better cognitive performance.

Independent variables: Social interaction. The social interaction variable was simple and clearly got at the amount of social interaction in which the participants engaged. The measure consisted of the mean of standardized responses to two questions ($r = .29$). These questions assessed the number of times participants talked on the phone with friends, neighbors, and relatives and how often they got together with these same parties. These questions were answered on 6-point scales (1 = *never*, 3 = *once a week [month]*, 6 = *more than once a day [week]*).

Covariates. We controlled for relevant demographic variables, including participants' age (measured in years), level of education (the higher the number, the higher the grade completed), race and ethnicity, gender, household income (coded as a continuous variable), and whether participants were married or living with a partner (0 = *no*, 1 = *yes*).

In the analysis we also controlled for measures of physical health and daily activity levels. The physical health measure consisted of the number of chronic health conditions reported by the participant (e.g., incidence of arthritis or rheumatism, high blood pressure, diabetes, fractures) (range = 0–7). The measure of physical health is particularly important as a control variable because it is a strong candidate for explaining variation not only in sociability (if you are ill you are unlikely to be very social) but also cognitive functioning (mental decline reflects physical decline).

TABLE 1: Means and Standard Deviations for the Measures of Social Interaction and Cognitive Performance as a Function of Age Group

Age Group	M	SD
Age range 24–41 ($n = 1,183$)		
Social interaction	4.54	1.10
Cognitive performance	11.74	1.76
Age range 42–64 ($n = 1,220$)		
Social interaction	4.33	1.19
Cognitive performance	11.28	2.25
Age range 65–96 ($n = 1,207$)		
Social interaction	4.43	1.25
Cognitive performance	10.54	3.02

NOTE: The means for the measure of cognitive performance are based on 7 extra participants (3 for middle age and 4 for older age) who had missing social interaction data.

Participants' assessments of their activities of daily living consisted of their responses to two questions that were scored on 4-point scales ($r = .30$). These questions measured the degree to which participants engaged in active sports or exercise, and how often they took walks (1 = *often*, 4 = *never*). Higher scores on this index indicate lower levels of daily activity.

The experience of depression has been associated with impaired cognitive functioning in many studies (Whalley, 2001). Therefore, we also controlled for participants' depressive symptoms. These consisted of four items that assessed the degree to which participants endorsed negative self-views and felt low self-efficacy, for example, "At times I think I am no good at all" and "There is really no way I can solve the problems I have." These questions were answered on 4-point scales (1 = *strongly agree*, 2 = *agree somewhat*, 3 = *disagree somewhat*, 4 = *strongly disagree*; Cronbach's $\alpha = .68$). The items were recoded so that higher scores indicate more depressed tendencies.

Results and Discussion

Table 1 presents the means for the social interaction and cognitive performance measure as a function of age group. The regression analyses were conducted as a two-stage elimination procedure. In the first stage only the covariates were entered into the model predicting cognitive performance. Any covariate that failed to meet the $p < .10$ criterion was excluded from the subsequent regression models. The excluded covariates were income level, daily activity level, and physical health.²

The second stage of the analysis involved classifying participants into one of three groups as a function of their age, young (24–41), middle age (42–64), and older age (65–96; see Table 2 for regression model results).

TABLE 2: Regression Models Testing the Relationship Between the Measure of Social Interaction and the Measure of Cognitive Performance as a Function of Age Group, Controlling for Reliable Covariates From Stage 1 of Analysis

Multivariate Model	Cognitive Performance	
	b	p
Age range 24–41		
Social interaction	.08	.007
R^2	.34	
Age range 42–64		
Social interaction	.05	.05
R^2	.49	
Age range 65–96		
Social interaction	.094	.0001
R^2	.55	

Then we performed separate regression analyses within each age group that included the covariates that met the stay criterion described previously and, more importantly, the social interaction variable. A backward elimination method, with a stay criterion of $p < .05$, was used to determine whether social interaction predicted cognitive functioning at the final stage of the regression analysis. The results indicated that social interaction was a reliable predictor of cognitive performance. The more participants interacted socially by talking to and visiting friends and relatives, the better their performance on the measure of cognitive functioning. Importantly, this predictive relationship was reliable for each of the age groups, including the youngest.

The findings from Study 1 indicate that the more socially engaged participants were, the higher their level of cognitive performance. This goes beyond available research in several ways. We had a direct measure of the amount of social interaction, and we studied a typical range of cognitive performance. More importantly, we examined people of various ages and found that this relation holds across the whole age spectrum, in the elderly, middle-age, and youngest groups.

The finding of a reliable association between specific measures of social interaction and cognitive performance among the youngest group is important not only empirically but theoretically as well. Specifically, it suggests that the effect of social interaction does not require an expanded time line before the benefits become apparent. And the implications of this possibility are not trivial, as even a few social interactions may potentially have recognizable benefits on cognitive performance.

It is important to note that the evidence for Study 1, and that of the previously reviewed research showing a relationship between social factors and cognitive functioning, is correlational in nature. Thus, one goal of

Study 2 was to conduct an experiment to determine whether social interaction in a group of younger adults can have a causal influence on cognitive performance. Related to this goal, Study 2 also tested the idea of whether a small amount of social interaction can have positive cognitive effects.

STUDY 2

The participants in Study 2 were randomly assigned to one of three conditions. These included a *social interaction* condition, an *intellectual activities* condition, and a *control* condition. The control and intellectual activities conditions were included as comparisons. Given the proposed, stimulating nature of “intellectual” and more academic activities (e.g., Schooler, Mulatu, & Oates, 1999), we hypothesized that participants in the intellectual activities condition would outperform those in the control condition. Of greater interest, given our argument that social interaction also helps exercise people’s brains and minds, and the correlational findings from Study 1, we hypothesized that participants in the social interaction condition would also outperform the controls. We had no strong theoretical basis for expecting differences in performance between the two experimental conditions, but a lack of a difference between the two would help support the idea that social interaction is similarly stimulating as activities traditionally characterized as “intellectual” in nature.

Method

Seventy-six participants (age range 18–21) took part in the experiment. The participants were randomly assigned to one of three conditions in which they were run as dyads by an experimenter blind to the hypotheses. Participants in the social interaction condition engaged in a discussion of a social issue for 10 min. The issue, which was the same for all participants, involved privacy protection, especially in light of recent technological advances and political events. Through the toss of a coin the experimenter assigned participants to either the pro or con position. Then they were given 4 min to read through the description of the topic and formulate their positions. They were then given the remaining 6 min to carry out their discussion, with the participant assigned the pro position asked to start the discussion.

Participants in the intellectual activities condition did not interact with each other. Their activity consisted of three tasks, a reading comprehension task (3 min), a crossword puzzle (4 min), and a mental rotation task (3 min; total time for the tasks combined was always 10 min). The participants were told that it was okay if they did not finish the tasks in the allotted time. Control

participants also did not interact with each other, but their task, which involved watching a 10-min clip of the sitcom *Seinfeld*, did have a social component. This aspect of the control condition helps to additionally distinguish the processes operating in the social interaction condition, as research has shown that watching television can help people satisfy social needs for interaction (Gardner, Pickett, & Knowles, 2005). If the social interaction participants cognitively outperform the controls, such a finding would suggest that face-to-face interaction or interacting with a live person is important in realizing cognitive benefits.

Immediately following the 10 min, regardless of condition, we asked participants to evaluate the activity they were asked to perform (i.e., social interaction, intellectual activities, or film clip), indicating how engaging, stimulating, and enjoyable they found the task to be (answers ranged from 1 = *not at all* to 6 = *very much so*; Cronbach’s alpha = .80).

Following the evaluation of the respective activities, for the next phase of the experimental session we assessed participants’ cognitive functioning. Although we could have used the cognitive functioning measure from Study 1 for ease of administration, in this study we used two different cognitive performance measures that were more stringent and intensive. They included a measure of processing speed and working memory. Both of these types of measures have been associated with various forms of cognitive performance and measures of IQ (e.g., Schatz, Kramer, Ablin, & Matthay, 2000).

The speed of processing task involved making same/different judgments as quickly as possible about two patterns of dots that were presented side by side on a sheet of paper (Park et al., 1996). On each sheet of paper there were multiple pairs for the participants to compare. The participants were timed and given 45 s per sheet (three sheets total) to do as many pattern comparisons as possible. The speed of processing score was determined by taking the number of comparisons participants answered correctly (across the three sheets) and dividing this number by the number of comparisons attempted to take accuracy into account.

The working memory task (reading span task) required participants to answer questions about sentences read aloud to them by the experimenter (processing component) while maintaining an element from each sentence in memory (storage component; Salthouse & Babcock, 1991). Initially participants were presented with three sets of two objects. Then participants immediately had to recall the objects. If they recalled at least two of the three sets of two objects, they moved to the next trial. For this next trial participants were presented with three sets of three objects. If they could recall two of the three sets (of three objects) correctly they

TABLE 3: Cognitive Performance as a Function of Experimental Condition

Cognitive Performance Measure	Condition					
	Social Interaction (n = 26)		Intellectual (n = 25)		Control (n = 25)	
	M	SD	M	SD	M	SD
Speed of processing	0.95	0.042	0.94	0.045	0.91	0.071
Working memory	10.54	1.42	10.52	2.02	9.48	1.39

NOTE: The greater the score, the better the performance.

proceeded to the next trial, and this could have continued until participants were presented with three sets of eight objects. The total number of correctly recalled sets (across trials) was taken as the measure of working memory performance.

Finally, after the working memory task participants filled out some demographic questions and were then fully debriefed and given course credit for their participation.

Results and Discussion

Table 3 shows the results of the experiment. For each dependent measure (speed of processing, working memory), we had two questions. First, does each of the two experimental groups (intellectual, social) differ from the control group? Second, do the two experimental groups differ from each other? We first conducted overall ANOVAs on each measure of cognitive performance and then followed up with planned contrasts to answer these questions.

In terms of performance on the speed of processing task (number correct/number attempted), there was an overall difference in cognitive performance among the conditions, $F(2, 73) = 3.91, p < .02$. Planned contrast analysis on the means shown in Table 3 revealed that the participants in the intellectual activities condition outperformed controls, $F(1, 48) = 4.23, p < .04$. Of greater interest, social interaction participants also outperformed controls, $F(1, 49) = 5.72, p < .02$. In addition, the two experimental groups did not differ from each other, $F(1, 49) < 1.00$. Importantly, there was no difference in the number of attempts by participants across the three conditions ($M_{\text{Intellectual}} = 17.12, M_{\text{Social}} = 17.77, M_{\text{Control}} = 18.40$), $F(2, 73) = 1.17, p < .31$. Thus, all participants were equally engaged with the second phase of the experimental session.

Working memory performance yielded equivalent results, with overall performance differences across conditions, $F(2, 73) = 3.46, p < .04$. Contrasts revealed that intellectual activities condition participants outperformed controls in terms of working memory performance, $F(1, 48) = 4.49, p < .04$. Similarly, social

interaction participants also outperformed controls, $F(1, 49) = 7.23, p < .01$. Again, both experimental groups did not differ from each other, $F(1, 49) < 1.00$.

Before the assessment of cognitive performance, we asked participants to evaluate the activities they performed (i.e., how enjoyable, engaging, stimulating they found the activities to be; 1 = *not at all*, 6 = *very much so*). Responses to these questions are of interest because it could be argued that mood or related motivational differences due to the experimental manipulation could have influenced cognitive performance. For example, participants in the video clip condition might have really enjoyed their activity and might have wanted to prolong it, which could have subsequently lowered their motivation when they were put through the cognitive performance measures. Although the lack of a difference on the number of attempts on the speed of processing task helps argue against this possibility, we wanted to examine the effects, if any, of how the activities were evaluated. We first analyzed whether there were any differences in evaluation. A between-subjects ANOVA across the three conditions showed no reliable differences, $F(2, 73) = 2.74, p < .07$. And even though there was a trend toward an overall difference, both the control (video) and social interaction conditions were rated more favorably than the intellectual activities condition and not differently from each other ($M_{\text{Intellectual}} = 3.39, M_{\text{Social Interaction}} = 4.05, M_{\text{Control}} = 3.91$). This in itself also argues against such an alternative account.

To further buttress this aspect of the results, we included the activity evaluation score as a covariate and repeated the analyses for speed of processing and working memory. The addition of this covariate did not alter the results for either measure of cognitive performance: speed of processing, $F(2, 72) = 3.91, p < .02$; working memory, $F(2, 72) = 3.38, p < .04$.

The results from Study 2 showed that short-term social interaction lasting 10 min boosted participants' cognitive performance to a comparable extent as having participants engage in so-called intellectual activities for the same amount of time. To our knowledge, this experiment represents the only causal evidence of the facilitative

effects of direct social interaction on cognitive performance (and maybe the only causal test of the influence of intellectual activities as well).

The focus on cognitively thriving younger adults in the present study, in addition to extending the purview of the social interaction–cognition link, served as a conservative test of the proposed causal influence of social interaction on cognitive functioning given that older adults perform more poorly than younger adults on a variety of cognitive functioning tasks (refer to Study 1; see also Craik, & Byrd, 1982; for a review see Park, 2000). Along more theoretical lines, the findings indicate that the effects of social interaction can be relatively immediate and can result from just a small amount of social interaction.

Experimenter observations of the social interactions in the present study indicated that participants planned their positions, took turns sharing them, anticipated the partner's points, and readied their counterpoints. Save for the constraints in which the interaction took place, the interactions appeared for the most part natural and coordinated. Although we do not have direct evidence for this, the interactions likely triggered the use of perspective taking, planning, and inference generation, processes that have been associated with executive functioning (Amodio & Frith, 2006; Baddeley, 2002). We posit that it is this that allows social interaction, through the preactivation of cognitive resources, to boost subsequent mental performance in a similar way to how the activation of specific concepts in memory readies semantically related knowledge and processes (Anderson, 1993; E. R. Smith, 1994). We argue that this process of resource priming (brief exercises of executive functions), which helps explain the effects of Study 2, if practiced regularly can create a more chronic elevation of cognitive resources, which may be the process captured in Study 1 (Olesen et al., 2004; Posner & Rothbart, 2005).

At this point, our findings and interpretation agree with cognitive and social neuroscience research, but only through future research will we be in a position to accept these interpretations more confidently. Some of this work might involve, for example, studying different types of interactions (getting to know someone or chit-chatting vs. discussion of an issue), manipulating the issue under discussion, introducing greater structure into the social interaction to target specific social cognitive processes (e.g., separately manipulating perspective taking, mentalizing, or inhibition components), and using neuroscience techniques to understand neural changes underlying the observed effects. We will continue our considerations of how social interactions can differ and their likely effects on cognition in the general discussion.

GENERAL DISCUSSION

Both studies suggest a facilitative effect of social interaction on intellectual performance. Study 1 showed that specific indicators of social interaction predicted cognitive performance among cognitively healthy participants and that this effect extends across a wide age spectrum, including the youngest participants. This study extended previous research with elderly and cognitively impaired populations. Study 2 followed up on these results by focusing on younger adults and the possibility that small amounts of social interaction can have causal effects on boosting cognitive performance. Compared to control participants, participants who interacted socially for 10 min showed better cognitive performance, performance equivalent to that displayed by participants engaged in so-called intellectual activities.

The findings showing that younger adults can reap cognitive benefits from socializing expand our conceptions of the social interaction–cognition link. Not only do the results show that the effect is causal but that the process is very sensitive to small amounts of social interaction. Reliance on the survey results with elderly participants, barring any consideration of measurement issues, provides little clue that such an effect could occur so immediately.

The process thus seems aligned with the possibility that social interaction can “exercise” general cognitive processes (working memory, speed of processing, inhibition) in the service of social cognition (e.g., empathy, mentalizing, symbolic interaction). It is possible that as people engage socially and mentally with others, they receive relatively immediate cognitive boosts, which then facilitate subsequent social interactions, receiving additional cognitive boosts, and so forth. This perspective suggests that anyone, older and younger alike, can do things that come naturally to most of us to stay cognitively engaged.

More generally, the current findings fit with the emphasis in the social cognition literature on the role of general processing resources in person perception and judgment (Lieberman et al., 2002). They also fit with recent research showing real practice-related changes in brain substrates underlying such fundamental functions as attention, working memory, and processing speed (Olesen et al., 2004; Posner & Rothbart, 2005). Importantly, these changes can occur in typical populations and can have short-term influences, presumably based on general mechanisms of activation, as well as long-term influences, presumably based on structural changes (Draganski et al., 2004). These findings are also consistent with research on other species showing that social enrichment improves cognitive performance, neuronal growth, and overall brain mass (Bennet, Rosenzweig,

& Diamond, 1969; Cummins, 1973; Lipkind, Nottebohm, Rado, & Barnea, 2002; Lomassese et al., 2000; Menzel, Davenport, & Rogers, 1970; Sandeman & Sandeman, 2000).

The Nature and Tenor of the Social Interaction

One issue that remains unclear from the present research is whether all types of social interaction can have a positive effect on cognitive performance. Some available research, although varying in method from the present research, suggests that some social interactions can be cognitively depleting (Finkel et al., 2006; Richeson & Trawalter, 2005; Richeson, Trawalter, & Shelton, 2005). For example, using a measure of inhibition, Richeson et al. (2005) showed that individuals high in prejudice or who had concerns about being viewed as prejudiced were worse at inhibiting interfering responses on a Stroop task. The research by Finkel et al. (2006) using as outcome measures anagrams and analytical tests from the Graduate Record Exam found depletion effects following interactions that were asynchronous or high-maintenance in nature. Both sets of findings were explained in terms of self-regulation deficits, although the emphases differed.

At a broader level, though, it may be possible to integrate these findings with the present research. Whether a social interaction is cognitively draining or cognitively energizing may depend on several factors. Most generally, it is worth noting that the emergence of facilitation or depletion effects with executive function tasks depends on the extent of resource pre-use. As an analogy, before a competition, athletes engage in warm-up exercises, without overdoing them and tiring themselves out. Similarly, performance on executive function tasks should benefit from earlier tasks with low and moderate difficulty and self-timing that allows for rest (e.g., our Study 2), but performance may be temporarily impaired by earlier tasks with high levels of difficulty, as typically used in depletion experiments (Muraven & Baumeister, 2000).

More specific to the nature of the social interactions, their effects should generally depend on whether the context involves approach or avoidance tendencies, two core aspects of how people tend to relate to each other (Chance, 1988). Social interactions that trigger avoidance are likely to be surrounded by a lack of structure or norms or an asynchronous dynamic, or they may involve people who under normal circumstances might not interact with each other or do so warily (e.g., strangers, outgroup members). Such social interactions may induce uncertainty and anxiety about what the other persons are like, how they will react, or what they are likely to do (cf. Stephan & Stephan, 1985), outcomes that may be particularly lethal to the ability to

self-regulate and to concomitant cognitive performance. In the research by Richeson et al. (2005), participants were made to feel concerned that they might be viewed as prejudiced, which might have induced anxiety and uncertainty, especially when they were told they would be videotaped and asked to disclose their opinions on racially sensitive topics. It is also possible that the high-maintenance conditions in the research by Finkel et al. (2006) might have induced frustration and facilitated inferences that the partner was not to be trusted, an outcome with the potential to short-circuit processes such as perspective taking.

Other interactions, in contrast, are more structured or allow for coordination, or may involve people who are more likely to interact with each other (e.g., friends, ingroup members). Such interactions, instead of eliciting a self-protective, reactive stance, may induce greater security, less anxiety, and at times greater communality. This captures to some degree the nature of the social interaction used in Study 2, in which participants interacted in a structured setting in which they were relatively interdependent and had to try to predict and understand each other's position. It may be this aspect of the social interaction that promotes a cognitive style that supports consequent cognitive boosts.

Finally, the possibility exists that the outcome measures used across the different studies may also play a role in determining whether cognitive depletion or cognitive boosts occur. Richeson et al. (2005) used a test of cognitive inhibition, whereas Finkel et al. (2006) used anagram and analytical reasoning tasks, in addition to tasks that involved handgrip effort and fine motor control. In the present research we used two general measures of cognitive resources, working memory and speed of processing. Further research is thus needed to more clearly determine what aspects of social interaction lead to cognitive boosts or cognitive depletion and the possible role of how cognitive performance is measured. The former emphasis strikes us as a particularly exciting area of inquiry. It has potential implications for research dealing with, for example, the effects of intergroup contact and diversity on cognitive performance, and how supportive and coordinated relationships, both romantic and nonromantic, may allow people to blossom cognitively.

Limitations of the Present Research

In addition to the issues discussed previously, a limitation of the present research concerns the correlational nature of Study 1. Although the findings from Study 2 provide causal evidence for the effect of social interaction on cognitive functioning, we cannot draw this conclusion with the same level of confidence for Study 1. The findings from Study 1 are equally suggestive of the

idea that people who are functioning better cognitively are better able to enter into social interactions with others, or there could be a third variable that accounts for both of these possibilities. At a broader level, though, the idea that more cognitively able people may enter into more social interactions is not inconsistent with the thrust of the present research. Such a relationship suggests that social interaction demands a requisite level of cognitive functioning, in line with the suggestions put forth by evolutionary biologists (Dunbar, 1992, 1995; Humphrey, 1976). It may indeed be this possibility that allows for social interaction to produce boosts in cognitive functioning, as demonstrated in Study 2.

The Social Is What We Do, and Thinking Is for Doing

In the Introduction we discussed how an alien visiting from another world would be impressed by the amount of time people spend doing things with other people. What is important to note is that such an alien could pay a visit now, could have visited 50,000 years ago, or 2 million years ago (in the time of *Homo habilis*) and in all cases be impressed by the role of social relations in people's lives. Social connections are at the core of primate life (Jolly, 1966) and are central to the human survival strategy (Barash, 1986; Baumeister, 2005; Dunbar, 1992, 1998).

Given the continual and tonic role of social interaction in people's lives, more specifically, the necessity to navigate a complex web of social relations in a mixed-motive world (Humphrey, 1976), it makes sense that our brains and minds would be very sensitive and responsive to that dimension of experience. Research in evolutionary biology has shown, for example, that the size of the primate neocortex is better predicted by how cognitively taxing a primate's species social environment is (as reflected in group size) rather than the demands of the physical ecology (Dunbar, 1992, 1995; Humphrey, 1976). In humans, research in social cognition has shown that compared to information of a nonsocial nature, people are faster at recognizing information that has social implications (Ybarra, Chan, & Park, 2001). Other research has shown that when people are first getting to know someone, they seek more information about the person's social rather than non-social-related tendencies (Wojciszke, Bazinska, & Jaworski, 1998). People's conversations with others also tend to revolve around the social dimensions of life (Dunbar, Marriott, & Duncan, 1997), and even while sleeping and dreaming people's minds are preoccupied with social relations (McNamara, McLaren, Smith, Brown, & Stickgold, 2005). Social neuroscience research has also shown that the default neural activity present in the human brain is

more aligned with the way people process social versus nonsocial information (Mitchell, Heatherton, & Macrae, 2002). People's psychology appears to be consistently attuned to the social world.

The social readiness of people's minds makes sense given that people's cognitive abilities many times operate in the service of social coordination and staying socially connected. In turn, social interaction and relationships not only sharpen our knowledge and social skills but also strengthen the cognitive processes that underlie those skills, which may then ready people for greater connection and effectiveness in dealing with others. Thus, an important outcome of social interaction appears to be mental sharpness, which in itself may play a central role in helping us enjoy the many other benefits that come from being socially connected. Thinking many times is for being social, and being social supports our thinking.

Conclusion

The current analysis complements other recommendations given for maintaining a healthy brain and mind (e.g., Verghese et al., 2003; Wilson et al., 2002). Usually it is assumed that activities that work the brain and mind are of a more "intellectual" and "technical" nature, such as reading, developing new hobbies, and learning to appreciate new aspects of one's culture (e.g., art, music). Such activities should undoubtedly play a role in keeping the brain and mind healthy.

But in light of current research and discussion, it may not be inappropriate to rephrase Descartes' philosophical statement as "I think about and with others, therefore I am." Other needs that are basic to us, such as being socially connected (Baumeister & Leary, 1995), by their very nature when fulfilled will engage people mentally. The mental gymnastics that come with social interaction need not take the place of other activities that exercise our minds, but they may produce the byproduct, whether intentional or not, of making our social lives more gratifying while providing boosts to our cognitive functioning.

NOTES

1. Some critics challenge Putnam's (2000) "Bowling alone" conclusion and suggest that people have as many social contacts now as in the past but that much of this social interaction has shifted to the Internet. However, what might be critical for proper cognitive and physical functioning is actual, face-to-face interaction with its dynamic and fast character. No amount of email, even "instant messaging," can supplement face-to-face interaction, as it does not have the same computational demands.

2. The analyses were also performed with all of the covariates included as part of the regression models (no exclusion). These analyses produced the same results as those reported.

REFERENCES

- Adolphs, R. (2001). The neurobiology of social cognition. *Current Opinion in Neurobiology*, 11, 231-239.
- Amodio, D. M., & Frith, C. D. (2006). Meeting of minds: the medial frontal cortex and social cognition. *Nature Reviews Neuroscience*, 7, 268-277.
- Anderson, J. R. (1993). *Rules of the mind*. Hillsdale, NJ: Lawrence Erlbaum.
- Arbuckle, T. Y., Gold, D. P., Andres, D., Schwartzman, A., & Chaikelson, J. (1992). The role of psychosocial context, age, and intelligence in memory performance of older men. *Psychology and Aging*, 7, 25-36.
- Aries, P. (1962). *Centuries of childhood: A social history of family* (Robert Baldick, Trans.). New York: Knopf.
- Baddeley, A. D. (2002). Fractionating the central executive. In D. Stuss & R. T. Knight (Eds.), *Principles of frontal lobe function* (pp. 246-260). New York: Oxford University Press.
- Barash, D. P. (1986). *Sociobiology and behavior*. New York: Elsevier.
- Baron-Cohen, S., & Ring, H. (1994). The relationship between EDD and ToM: Neuropsychological and neurobiological perspectives. In P. Mitchell & C. Lewis (Eds.), *Origins of an understanding of mind* (pp. 183-207). Hillsdale, NJ: Lawrence Erlbaum.
- Bassuk, S. S., Glass, T. A., & Berkman, L. F. (1999). Social disengagement and incident cognitive decline in community-dwelling elderly persons. *Annals of Internal Medicine*, 131, 165-173.
- Baumeister, R. F. (2005). *The cultural animal: Human nature, meaning, and social life*. New York: Oxford University Press.
- Baumeister, R. F., DeWall, C. N., Ciarocco, N. J., & Twenge, J. M. (2005). Social exclusion impairs self-regulation. *Journal of Personality and Social Psychology*, 88, 589-604.
- Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 11, 497-529.
- Baumeister, R. F., Twenge, J. M., & Nuss, C. (2002). Effects of social exclusion on cognitive processes: Anticipated aloneness reduces intelligent thought. *Journal of Personality and Social Psychology*, 83, 817-827.
- Bennet, E. L., Rosenzweig, M. R., & Diamond, M. C. (1969). Rat brain: Effects of environmental enrichment on wet and dry weights. *Science*, 163, 825-826.
- Blumberg, H. P., Stern, E., Ricketts, S., Martinez, D., de Asis, J., White, T., et al. (1999). Rostral and orbital prefrontal cortex dysfunction in the manic state of bipolar disorder. *American Journal of Psychiatry*, 156, 1986-1988.
- Brunet, E., Sarfati, Y., Hardy-Bayle, M. C., & Decety, J. (2000). A PET investigation of the attribution of intentions with a nonverbal task. *Neuroimage*, 11, 157-166.
- Cartwright, D., & Zander, A. (1953). *Group dynamics: Research and theory*. Evanston, IL: Row, Peterson.
- Chance, M. R. A. (1988). *Social fabrics of the mind*. Hillsdale, NJ: Lawrence Erlbaum.
- Craik, F. I. M., & Byrd, M. (1982). Aging and cognitive deficits: The role of attentional resources. In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes* (pp. 191-211). New York: Plenum.
- Cummins, R. A. (1973). Environmentally-induced changes in the brains of elderly rats. *Nature*, 243, 516-518.
- Damasio, A. R. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York: Putnam.
- Draganski, B., Gaser, C., Busch, V., Schuierer, G., Bogdahn, U., & May, A. (2004). Neuroplasticity: changes in grey matter induced by training. *Nature*, 427, 311-312.
- Dunbar, R. I. M. (1992). Neocortex size as a constraint on group size in primates. *Journal of Human Evolution*, 20, 469-493.
- Dunbar, R. I. M. (1995). Neocortex size and group size in primates: A test of the hypothesis. *Journal of Human Evolution*, 28, 287-296.
- Dunbar, R. I. M. (1998). The social brain hypothesis. *Evolutionary Anthropology*, 6, 178-190.
- Dunbar, R. I. M., Marriott, A., & Duncan, N. D. C. (1997). Human conversational behavior. *Human Nature*, 8, 231-246.
- Fabrigoule, C., Letenneur, L., Dartigues, J. F., Zarrouk, M., Commenges, D., & Barberger-Gateau, P. (1995). Social and leisure activities and risk of dementia: A prospective longitudinal study. *Journal of the American Geriatrics Society*, 43, 485-490.
- Finkel, E. J., Campbell, W. K., Brunell, A. B., Dalton, A. N., Scarbeck, S. J., & Chartrand, T. L. (2006). High maintenance interaction: Inefficient coordination impairs self-regulation. *Journal of Personality and Social Psychology*, 91, 456-475.
- Fletcher, P. C., Happe, F., Frith, U., Baker, S. C., Dolan, R. J., Frackowiak, R. S., et al. (1995). Other minds in the brain: A functional imaging study of "theory of mind" in story comprehension. *Cognition*, 57, 109-128.
- Folstein, M., Folstein, S., & McHugh, P. (1975). Mini-mental state: A practical method for grading the mental state of patients for the clinician. *Journal of Psychiatric Research*, 12, 189-198.
- Fratiglioni, L., Wand, H., Ericsson, K., Maytan, M., & Winblad, B. (2000). Influence of social network on occurrence of dementia: A community-based longitudinal study. *Lancet*, 355, 1315-1319.
- Frith, C. D., & Frith, U. (1999). Interacting minds—A biological basis. *Science*, 286, 1692-1695.
- Gardner, W. L., Pickett, C. L., & Knowles, M. (2005). Social snacking and shielding: Using social symbols, selves, and surrogates in the service of belonging needs. In K. D. Williams, J. P. Forgas, & W. V. Hippel (Eds.), *The social outcast: Ostracism, social exclusion, rejection, and bullying* (pp. 227-242). New York: Psychology Press.
- Gilbert, D. T., Pelham, B. W., & Krull, D. S. (1988). On cognitive busyness: When person perceivers meet persons perceived. *Journal of Personality and Social Psychology*, 54, 733-740.
- Gladstone, G. L., Parker, G. B., Malhi, G. S., & Wilhelm, K. A. (2007). Feeling unsupported? An investigation of depressed patients' depression. *Journal of Affective Disorders*, 103, 147-154.
- Heider, F. (1958). *The psychology of interpersonal relations*. New York: John Wiley.
- House, J. S. (1986). *The survey of Americans' changing lives* [Data file]. Ann Arbor, MI: Institute for Social Research.
- House, J. S., Landis, K. R., & Umberson, D. (1988). Social relationships and health. *Science*, 241, 540-545.
- Humphrey, N. K. (1976). The social function of intellect. In P. P. G. Bateson & R. A. Hinde (Eds.), *Growing points in ethology* (pp. 303-317). Cambridge, UK: Cambridge University Press.
- Jolly, A. (1966). Lemur social behavior and primate intelligence. *Science*, 153, 501-506.
- Kiecolt-Glaser, J., Garner, W., Speicher, C., Penn, G., & Glaser, R. (1984). Psychosocial modifiers of immunocompetence in medical students. *Psychosomatic Medicine*, 46, 7-14.
- Kling, A., & Steklis, H. D. (1976). A neural substrate for affiliative behavior in nonhuman primates. *Brain, Behavior and Evolution*, 13, 216-238.
- Kling, A. S. (1986). Neurological correlates of social behavior. *Ethology and Sociobiology*, 7, 175-186.
- Kondo, K., & Yamashita, I. (1990). A case-control study of Alzheimer's disease in Japan: Association with inactive psychosocial behaviors. In K. Hasegawa & A. Homma (Eds.), *Psychogeriatrics: Biochemical and social advances* (pp. 49-53). Amsterdam: Excerpta Medica.
- Lieberman, M. D., Gaunt, R., Gilbert, D. T., & Trope, Y. (2002). Reflection and reflexion: A social cognitive neuroscience approach to attributional inference. *Advances in Experimental Social Psychology*, 34, 199-249.
- Lipkind, D., Nottelbohm, F., Rado, R., & Barnea, A. (2002). Social change affects the survival of new neurons in the forebrain of adult songbirds. *Behavioural Brain Research*, 133, 31-43.
- Lomassese, S. S., Strambi, C., Strambi, A., Charpin, P., Augier, R., Aouane, A., et al. (2000). Influence of environmental stimulation on neurogenesis in the adult insect brain. *Journal of Neurobiology*, 45, 162-171.
- McGuire, M. T., & Raleigh, M. J. (1986). Behavioral and physiological correlates of ostracism. *Ethology and Sociobiology*, 7, 187-200.

- McNamara, P., McLaren, D., Smith, D., Brown, A., & Stickgold, R. (2005). A "Jekyll and Hyde" within: Aggressive versus friendly interactions in REM and non-REM dreams. *Psychological Science, 16*, 130-136.
- McPherson, M., Smith-Lovin, L., & Brashears, M. E. (2006). Discussion networks over two decades. *American Sociological Review, 71*, 353-375.
- Mead, G. H. (1934). *Mind, self and society from the standpoint of the social behaviorist*. Chicago: University of Chicago Press.
- Menzel, E. W., Davenport, R. K., & Rogers, C. M. (1970). The development of tool-using in wild-born and restriction-reared chimpanzees. *Folia Primat, 12*, 273-283.
- Mitchell, J. P., Heatherton, T. F., & Macrae, C. N. (2002). Distinct neural systems subserve person and object knowledge. *Proceedings of the National Academy of Sciences, 99*, 15238-15243.
- Moll, J., de Oliveira-Souza, R., Bramati, I. E., & Grafman, J. (2002). Functional networks in emotional moral and nonmoral social judgments. *Neuroimage, 16*, 696-703.
- Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin, 126*, 247-259.
- Myers, R. E., Swett, C., & Miller, M. (1973). Loss of social group affinity following prefrontal lesions in free-ranging macaques. *Brain Research, 64*, 257-269.
- Nielson, K. A., Langenecker, S. A., & Garavan, H. (2002). Differences in the functional neuroanatomy of inhibitory control across the adult life span. *Psychology and Aging, 17*, 56-71.
- Olesen, P. J., Westerberg, H., & Klingberg, T. (2004). Increased prefrontal and parietal activity after training of working memory. *Nature Neuroscience, 7*, 75-79.
- Park, D. C. (2000). The basic mechanisms accounting for age-related decline in cognitive function. In D. C. Park & N. Schwarz (Eds.), *Cognitive aging: A primer* (pp. 3-22). Philadelphia: Psychology Press.
- Park, D. C., Smith, A. D., Lautenschlager, G., Earles, J., Frieske, D., Zwahr, M., et al. (1996). Mediators of long-term memory performance across the life span. *Psychology and Aging, 11*, 621-637.
- Posner, M. I., & Rothbart, M. K. (2005). Influencing brain networks: Implications for education. *Trends in Cognitive Science, 9*, 99-103.
- Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. New York: Simon & Schuster.
- Richeson, J. A., & Trawalter, S. (2005). Why do interracial interactions impair executive function? A resource depletion account. *Journal of Personality and Social Psychology, 88*, 934-947.
- Richeson, J. A., Trawalter, S., & Shelton, N. J. (2005). African Americans' implicit racial attitudes and the depletion of executive function after interracial interactions. *Social Cognition, 23*, 336-352.
- Royall, D. R., Lauterbach, E. C., Cummings, J. L., Reeve, A., Rummans, T. A., Kaufer, D. I., et al. (2002). Executive control function: A review of its promise and challenges for clinical research. *Journal of Neuropsychiatry and Clinical Neuroscience, 14*, 377-405.
- Salthouse, T. A., & Babcock, R. L. (1991). Decomposing adult age differences in working memory. *Developmental Psychology, 27*, 763-776.
- Sandeman, R., & Sandeman, D. (2000). "Impoverished" and "enriched" living conditions influence the proliferation and survival of neurons in crayfish brain. *Journal of Neurobiology, 45*, 215-226.
- Schatz, J., Kramer, J. H., Ablin, A., & Matthay, K. K. (2000). Processing speed, working memory, and IQ: A developmental model of cognitive deficits following cranial radiation therapy. *Neuropsychology, 14*, 189-200.
- Schooler, C., Mulatu, M. S., & Oates, G. (1999). The continuing effects of substantively complex work on the intellectual functioning of older workers. *Psychology and Aging, 14*, 483-506.
- Seeman, T. E., Lusignolo, T. M., Albert, M., & Berkman, L. (2001). Social relationships, social support, and patterns of cognitive aging in healthy, high-functioning older adults: MacArthur studies of successful aging. *Health Psychology, 20*, 243-255.
- Shallice, T. (1988). *From neuropsychology to mental structure*. Cambridge, UK: Cambridge University Press.
- Singley, M. K., & Anderson, J. R. (1989). *Transfer of cognitive skill*. Cambridge, MA: Harvard University Press.
- Sinha, J. B. P., & Verma, J. (1990, July). *Social support as a moderator of the relationship between allocentrism and psychological well-being*. Paper presented at the Individualism-Collectivism Conference, Seoul, Korea.
- Smith, E. E., & Jonides, J. (1999). Storage and executive processes in the frontal lobes. *Science, 283*, 1657-1661.
- Smith, E. R. (1994). Procedural knowledge and processing strategies in social cognition. In R. S. Wyer Jr. & T. K. Srull (Eds.), *Handbook of social cognition* (2nd ed., Vol. 1, pp. 99-151). Hillsdale, NJ: Lawrence Erlbaum.
- Stephan, W. G., & Stephan, C. W. (1985). Intergroup anxiety. *Journal of Social Issues, 41*, 157-175.
- Stone, V. E., Baron-Cohen, S., & Knight, R. T. (1998). Frontal lobe contributions to theory of mind. *Journal of Cognitive Neuroscience, 10*, 640-656.
- Triandis, H. C., Bontempo, R., Betancourt, H., Bond, M., Leung, K., Brenes, K., et al. (1986). The measurement of etic aspects of individualism and collectivism across cultures. *Australian Journal of Psychology, 38*, 257-267.
- Trope, Y. (1986). Identification and inferential processes in dispositional attribution. *Psychological Review, 93*, 239-257.
- Verghese, J., Lipton, R. B., Katz, M. J., Hall, C. B., Derby, C. A., Kuslansky, G., et al. (2003). Leisure activities and the risk of dementia in the elderly. *New England Journal of Medicine, 348*, 2508-2516.
- Whalley, L. (2001). *The aging brain*. New York: Columbia University Press.
- Wilson, R. S., Krueger, K. R., Arnold, S. E., Schneider, J. A., Kelly, J. F., Barnes, L. L., et al. (2007). Loneliness and risk of Alzheimer disease. *Archives of General Psychiatry, 64*, 234-240.
- Wilson, R. S., Mendes de Leon, C. F., Barnes, L. L., Schneider, J. A., Bienias, J. L., Evans, D. A., et al. (2002). Participation in cognitively stimulating activities and risk of incident of Alzheimer disease. *Journal of the American Medical Association, 287*, 742-748.
- Wojciszke, B., Bazinska, R., & Jaworski, M. (1998). On the dominance of moral categories in impression formation. *Personality and Social Psychology Bulletin, 24*, 1251-1263.
- Ybarra, O., Chan, E., & Park, D. (2001). Young and old adults' concerns about morality and competence. *Motivation and Emotion, 25*, 85-100.

Received March 11, 2007

Revision accepted August 10, 2007