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Executive Dysfunctions Across Adulthood: Measurement Properties and Correlates of the DEX Self-Report Questionnaire

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ABSTRACT

Difficulties in executive processes can disturb daily life functioning. Using data obtained from two independent community-dwelling samples ($n_1 = 468$, $n_2 = 669$, 18–97 years), we examined the factor structure of the Dysexecutive Functioning Questionnaire (DEX) and explored the frequencies and potential correlates of self-reported executive difficulties. Our results revealed that executive problems are parsimoniously described with one underlying factor. Everyday executive dysfunctions were moderately frequent throughout adulthood. Reports of executive problems were associated with individual difference characteristics including age, subjective health, personality, affect, and cognition. We also found that, although executive functions are known to decline with advancing adult age, younger age groups reported more problems than older groups, an effect that was partially mediated by a negative affect factor. We discuss implications for the validity of the instrument as well as directions for future research on executive functioning difficulties in everyday life.

Keywords: Adult lifespan; Executive functions; Structural equation modeling; Test validity.

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INTRODUCTION

Various forms of executive difficulties such as experiencing cognitive-behavioral problems in sustaining attention, inhibiting inappropriate behaviors, or switching among problem-solving strategies can disturb daily life functioning and thus constitute threats to the quality of life throughout adulthood and old age (Baltes & Baltes, 1990; Lawton, 1983; Rowe & Kahn, 1997; Salthouse, in press; Ryff & Singer, 1998). Little is known, however, about how often such executive dysfunctions are experienced in everyday life, whether they are more frequent among certain age groups, and to what extent other factors such as negative affect or health might be involved in such executive difficulties. The major objectives of the present study are to examine two sets of questions about the nature and functional implications of self-reported behavioral difficulties in everyday executive functioning across the entire adult age range. First, we examine the measurement properties of the Dysexecutive Questionnaire (DEX; Wilson, Alderman, Burgess, Emslie, & Evans, 1996), an instrument designed to assess everyday signs of executive difficulties, including the underlying factor structure and its invariance across age groups and independent samples. Second, we explore the frequency of executive dysfunctions in everyday life across various phases of adulthood and investigate a variety of individual difference characteristics including age, gender, health, affect, personality, and cognitive functioning as potential correlates of the DEX.

Deficits in executive processes encompass such diverse cognitive components as difficulties in attention control, working memory and reasoning, as well as planning and sequencing behavior (Baddeley, 1990; Schwartz, 1995; Wilson, Evans, Emslie, & Burgess, 1998). In its clinically significant form, for example, dysexecutive individuals are characterized as being easily distracted, disinhibited, poor at decision-making, and unable to perform tasks that involve organization or planning over an extended period of time (cf. Parkin, 1998). In addition to these cognitive difficulties, affective and motivational problems are frequently observed as well. These problems may include euphoria, apathy, aggression, restlessness, or variable motivation. The general pattern of executive difficulties closely resembles what has previously been known as "frontal-lobe syndrome" (Stuss & Benson, 1984). To avoid the difficult situation of defining a set of cognitive problems in terms of its proposed anatomical location, the terms executive dysfunctions or dysexecutive syndrome are used here.

Various self- or informant-report measures have been specifically designed to sample the range of everyday signs of cognitive, behavioral, and affective-motivational changes often associated with executive difficulties (for review, see Malloy & Grace, 2005). Such questionnaires may help us to better understand the processes underlying rather mild forms of executive

problems in everyday life including lapses of intention, slips of action, or errors in goal-directed behavior (Chan, 2001; Reason, 1993). Previous studies using these questionnaires have, for example, indicated that the typical under-reports of executive dysfunctions among neurological patients are not found in non-clinical samples suggesting that community-dwelling individuals monitor and report executive problems in everyday life more accurately (Burgess, Alderman, Evans, Emslie, & Wilson, 1998; Chan, 2001).

One commonly used rating scale is the Dysexecutive Questionnaire (DEX), which has been shown to be a sensitive and ecologically valid instrument for tapping executive problems (Burgess et al., 1998; Chan, 2001). Initial factor analytic studies in (often relatively small) clinical populations have shown that the DEX encompasses several distinct factors. Using the reports of relatives of neurological patients in mid-adulthood, some authors have reported that the DEX encompasses three factors, namely cognition, behavior, and emotion (Wilson et al., 1998; see also Stuss & Benson, 1984, 1986), whereas others have identified five factors (inhibition, intentionality, executive memory, positive affect, and negative affect: Burgess et al., 1998; see also Amevia, Phillips, & Sala, 2003). Less is known, however, about the factor structure of self-reported executive dysfunctions in non-clinical samples of community-dwelling adults or whether such a factor structure differs across the adult age range. For example, demonstrating factorial invariance across age constitutes a key step towards directly examining questions about age-related differences in the frequencies of executive problems or their relation with other individual difference characteristics. Initial evidence suggests that at least some of the factors identified in clinical populations can also be found in non-clinical studies (Mooney, Walmsley, & McFarland, 2006: inhibition, intention, social regulation, and abstract problem solving; see also Chan, 2001).

It is also largely an open question how often people experience executive dysfunctions in everyday life and how this may differ by age. Age-graded decline in relevant cognitive abilities (Lindenberger & Baltes, 1997; Salthouse, 2004; Schaie, 2005) may suggest that the elderly report such instances more frequently. At the same time, findings of better emotion regulation with increasing age (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Lawton, Kleban, & Dean, 1993; Mroczek & Kolarz, 1998; Roecke, 2006) suggest that the elderly may handle such emotionally challenging situations better or be able to avoid these situations to some extent, thus experiencing executive dysfunctions less frequently. In a similar vein, little is known whether more executive problems also relate to certain individual difference characteristics. In line with its conceptual rationale, Burgess et al. (1998) reported that the DEX (in its informant-rated version) correlated well with performance on executive tasks. However, it also has repeatedly been acknowledged that executive dysfunctions may not necessarily relate to low performance in typical psychometric or neurological tests of cognitive abilities

(Chan, 2001; Shallice & Burgess, 1991; see also Rabbitt, 1997). In addition, empirically demonstrating associations of the DEX with other individual difference characteristics such as reports of negative affect, poor health, or certain personality characteristics (e.g., neuroticism; Gold & Arbuckle, 1990) may also contribute to better understand the nature of reports of dysexecutive behaviors.

The present study attempts to extend and qualify previous insights gained about executive dysfunctions by addressing two sets of questions. In a first step, we investigate the factor structure of the Dysexecutive Questionnaire using self-report data from community-dwelling individuals. In line with the proposed nature of dysexecutive behaviors as well as reports from clinical and non-clinical studies, we expect the DEX to encompass various distinguishable factors reflecting cognitive, behavioral, and affective-motivational aspects. We then determine the invariance of the factor structure found across age groups of young (18–39 years), middle-aged (40–59 years), and older adults (60+ years) and across two moderately large independent samples ($n=468$ and $n=669$). With the measurement properties of the DEX established, we examine in a second step how often community-dwelling adults experience executive problems in their daily lives and whether such frequencies differ by age group. We also explore relations of executive problems to typical individual difference correlates such as gender, health, affect, personality, and cognitive functioning.

METHOD

Participants and Procedure

The current project used data collected in two separate studies carried out at the Cognitive Aging Laboratory at the University of Virginia, Charlottesville, in the years 2004 (Study 1) and 2005 (Study 2). Detailed descriptions of the procedures and variables are reported in Salthouse, Siedlecki, and Krueger (2006). In Study 1, 468 adults (18–97 years; 62% women) with valid data on the DEX were included in the present analyses. These persons did not differ from those excluded due to missing data on demographic (age, gender) and health variables. Similarly, the 669 adults (18–94 years; 66% women) included in Study 2 also did not differ from those excluded due to missing data on the DEX. Characteristics of the two samples are presented in Table 1, separately for the three age groups: young (18–39 years), middle-aged (40–59 years), and older adults (60+ years). Participants were highly educated (>15 years, on average), they rated themselves as healthy (4.0, on average, on a 5-point scale), and their average scores on two standardized cognitive measures (Digit Symbol and Vocabulary) were above the age-adjusted norms. Participants were primarily recruited by newspaper advertisements, study flyers, and referrals from other participants.

TABLE 1. Participant characteristics: Means, standard deviations, and age correlations for the DEX Questionnaire and individual difference variables, separately for the two samples

Variable	Study 1				Study 2			
	18–39	40–59	60–97	r_{Age}	18–39	40–59	60–97	r_{Age}
N	125	181	162	—	200	249	220	—
DEX (0–4)	1.2 (0.6)	1.1 (0.7)	0.9 (0.6)	−.19*	1.2 (0.6)	0.9 (0.6)	0.8 (0.6)	−.22*
Age	28.1 (5.9)	50.3 (5.4)	70.9 (8.2)	—	25.0 (5.8)	50.5 (5.5)	71.9 (8.1)	—
% Women	63	67	57	—	58	76	62	—
Education	15.2 (2.1)	15.9 (2.6)	15.8 (3.0)	.11	14.8 (2.2)	15.3 (2.7)	16.1 (3.2)	.19*
Mini-Mental State (0–30)	29.2 (1.2)	28.8 (1.4)	28.5 (2.1)	−.19*	28.9 (1.5)	28.6 (1.8)	28.2 (2.0)	−.18*
Trait anxiety (1–4)	1.9 (0.5)	1.9 (0.5)	1.6 (0.4)	−.26*	2.0 (0.5)	1.9 (0.5)	1.7 (0.5)	−.24*
Subjective health (1–5)	4.2 (0.8)	4.0 (0.9)	3.7 (0.9)	−.23*	4.2 (0.8)	3.9 (0.8)	3.8 (0.8)	−.20*
Depression (0–60)	11.7 (7.4)	11.9 (8.3)	8.1 (5.6)	−.18*	13.8 (8.4)	12.4 (9.1)	9.4 (8.2)	−.18*
Positive affect (1–5)	2.9 (0.7)	3.1 (0.8)	3.3 (0.7)	.21*	2.8 (0.7)	3.0 (0.8)	3.2 (0.7)	.21*
Negative affect (1–5)	1.3 (0.4)	1.3 (0.5)	1.2 (0.3)	−.15*	1.4 (0.5)	1.4 (0.6)	1.2 (0.4)	−.15*
Neuroticism (1–5)	2.9 (0.7)	2.9 (0.7)	2.9 (0.9)	.01	2.9 (0.5)	2.8 (0.6)	2.6 (0.6)	−.17*
Digit Symbol (10–27)	85.6 (14.0)	74.3 (14.6)	60.3 (16.0)	−.59*	84.3 (15.9)	72.8 (15.6)	56.9 (16.4)	−.60*
Vocabulary (6–66)	50.6 (9.3)	51.8 (9.8)	52.4 (10.5)	.03	50.3 (11.2)	50.2 (12.3)	52.4 (9.2)	.07

Note. M (SD). Study 1, N=468; Study 2, N=669. *p < .01.

Measures

Dysexecutive Questionnaire

The DEX is a 20-item questionnaire that supplements the Behavioral Assessment of the Dysexecutive Syndrome (BADS: Wilson et al., 1996) and was used in its self-report version in the current studies. The 20 items purport to assess four areas of functioning associated with executive difficulties: emotional and personality changes (e.g., "*I have difficulty showing emotion*"), motivational changes (e.g., "*I seem lethargic and unenthusiastic about things*"), behavioral changes (e.g., "*I act without thinking, doing the first thing that comes to mind*"), and cognitive changes (e.g., "*I have difficulty thinking ahead or planning for the future*"). Each item is scored on a 5-point Likert scale ranging from 0 (never) to 4 (very often). Cronbach's alphas were high in the two studies ($\alpha \geq .90$).

Correlates

To examine associations between the DEX and individual difference characteristics, sociodemographic information and measures of health, personality, affect, and cognition were obtained in both samples. *Sociodemographic information* included chronological age, gender, and years of education. To examine aspects of *health*, we considered subjective health and depression. Subjective health was examined by asking participants to rate their current health on a scale from 1 (excellent) to 5 (poor). In our analyses, scores for subjective health were reverse coded so that higher scores indicate better health ratings. As a measure of depression, the Center for Epidemiological Studies-Depression scale (CES-D; Radloff, 1977) was used, which involves 20 items that ask participants how often over the last week they have felt depressive symptoms such as restless sleep or sad feelings. As a facet of *personality*, we used neuroticism as measured by Goldberg's (1999) Personality Inventory, which asks participants to rate 10 self-description items on a scale from 1 (very inaccurate) to 5 (very accurate). We also assessed trait anxiety as measured by the 20-item Trait Anxiety subscale of the STAI (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) that asks participants to report how strong they felt certain emotions in general. As an indicator of *affect*, we used the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988), which asks participants to rate the extent to which they currently felt 10 positive and 10 negative emotions on a scale from 1 (very slightly or not at all) to 5 (extremely). Finally, *cognitive functioning* was assessed using the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) as well as the Digit Symbol test and the Vocabulary test, both taken from the WAIS III (Wechsler, 1997).

Data Preparation

Table 1 shows descriptive statistics for the DEX as well as information about individual difference variables and their age correlations, separately for the samples from the two studies. Generally consistent with the extant literature, increased age was associated with lower levels of cognitive functioning (MMSE, Digit Symbol), trait anxiety, subjective health, depression, and negative affect, and also with higher levels of positive affect. Overall, participant characteristics and age correlations were similar across the two samples.

RESULTS

Results are presented in two sections. In a first step, we report analyses of the measurement properties of the DEX and also determine the invariance of the factor model found across several adult age groups and the two studies. In a second step, we examine the frequency of experiencing executive dysfunctions in everyday life across various age groups of young, middle-aged, and older adults. We also explore whether differences in the DEX were related to individual difference characteristics including gender, subjective health, affect, personality, and cognitive functioning. To guard against inflation of Type I error, the alpha level was set to $p < .01$.

Factor Structure of the Dysexecutive Questionnaire

To determine the factor structure of the DEX, we proceeded in a confirmatory manner and fitted a series of factor models derived from the studies reviewed above to our data by using M*plus* (Muthén & Muthén, 1998). Table 2 reports results from a hierarchically nested model comparison, separately for Study 1 and Study 2. As can be seen, a one-factor model using the 20 questionnaire items of the DEX as separate indicators was the most parsimonious model and thus served as the reference in this model comparison. All other models were nested within the one-factor model, but were not necessarily nested among one another.

Relative to a less parsimonious two-factor model (cognition-behavior and affect), the one-factor model in Study 1 resulted in only marginal loss of fit (i.e., three χ^2 units per one df). As compared with the three-factor model (cognition, behavior, and affect; see Wilson et al., 1998), the loss in model fit for the one-factor model was substantial (i.e., 59 χ^2 units per three df) suggesting that the three-factor model described the data in Study 1 relatively better. In contrast, losses in model fit when comparing the four-factor model (inhibition, intention, social regulation, and abstract problem solving; see Mooney et al., 2006) and the five-factor model (inhibition, intentionality, executive memory, positive affect, and negative affect; see Burgess et al.,

TABLE 2. Comparison of the one-factor model of the Dysexecutive Questionnaire to several multiple factor models, separately for Study 1 and Study 2

Model	χ^2	df	$\triangle\chi^2$/df	AIC	BIC	CFI	RMSEA
				Goodness of fit indices			
Study 1							
One factor	529	170	–	25,298	25,546	.882	.067
Two factors	526	169	3/1[1]	25,297	25,550	.883	.067
Wilson model (three factors)	470	167	59/3[1]	25,245	25,506	.901	.062
Mooney model (four factors)	494	164	35/6[1]	25,275	25,549	.892	.066
Burgess model (five factors)[2]	509	161	20/9[1]	25,296	25,582	.886	.068
Study 2							
One factor	874	170	–	36,171	36,441	.826	.079
Two factors	848	169	26/1[1]	36,147	36,422	.832	.077
Wilson model (three factors)	726	167	148/3[1]	36,029	36,313	.862	.071
Mooney model (four factors)	752	164	122/6[1]	36,061	36,358	.854	.073
Burgess model (five factors)[2]	761	161	113/9[1]	36,077	36,388	.851	.075

Note. Study 1, *N*=468; Study 2, *N*=669. Note that all other models are nested within the one-factor model, but not necessarily nested among one another.

[1]As compared with the one-factor model.

[2]For model identification, the two indicators of negative affect were fixed to be equal. AIC, Akaike's Information Criterion; BIC, Bayesian Information Criterion; CFI, Comparative Fit Index; RMSEA, Root Mean Square Error of Approximation.

1998) with the one-factor model, respectively, were less pronounced. Other model fit indices shown in Table 2 also indicate that a three-factor model of the DEX, relative to the other models, provides the most parsimonious account (lowest AIC and BIC) as well as the best description of the structure in the data (highest CFI, lowest RMSEA). Analyses of Study 2 data revealed similar results in that the largest loss in model fit was observed for comparing the one-factor model and the three-factor Wilson model.

However, we would like to highlight two points of caution. First, all five models considered provide poor fit to the data in absolute terms. Specifically, a Comparative Fit Index (CFI) close to or lower than .90 is generally considered poor statistical fit. Second, factor intercorrelations were found to be very high in all models, as indicated in Table 3. That is, 30 out of possible 40 factor intercorrelations were above $r = .85$ with a median intercorrelation of $r = .89$. In the three-factor model, for example, behavioral and affective aspects of the DEX showed a perfect intercorrelation. Such a pattern of results questions the distinctiveness of these factors, and it essentially suggests a parsimonious one-factor structure underlying the DEX. This interpretation is also in line with results from a series of exploratory factor analyses we carried out separately for the two studies. Independent of specifying an orthogonal or oblique solution, we found that the eigenvalue for one factor

TABLE 3. Intercorrelations among the factors identified in various factor models, separately for Study 1 and Study 2

Factors	Model				
	Two factors				
	Cognition-behavior	Affect			
Cognition-behavior	–	0.98 (0.93)			
Affect		–			
	Three factors				
	Cognition	Behavior	Affect		
Cognition	–	0.88 (0.79)	0.89 (0.85)		
Behavior		–	1.00 (1.00)		
Affect			–		
	Four factors				
	Inhibition	Intention	Social regulation	Problem solving	
Inhibition	–	0.91 (0.82)	0.88 (0.81)	0.88 (0.93)	
Intention		–	0.93 (0.86)	0.91 (0.82)	
Social regulation			–	0.89 (0.92)	
Problem solving				–	
	Five factors				
	Inhibition	Intentionality	Executive memory	Positive affect	Negative affect
Inhibition	–	0.95 (0.95)	0.99 (0.99)	0.99 (0.99)	0.83 (0.83)
Intentionality		–	0.93 (0.93)	0.89 (0.89)	0.85 (0.85)
Executive memory			–	0.98 (0.98)	0.81 (0.81)
Positive affect				–	0.81 (0.81)
Negative affect					–

Note. Intercorrelation in Study 1 (Study 2). Study 1, $N=468$; Study 2, $N=669$. All correlations, $p < .01$.

was consistently above 7, whereas four or five other factors could have been extracted, but their eigenvalues were only marginally larger than 1.[1]

In the next step, we attempted to find an appropriate and parsimonious factorial representation of the DEX by combining the above two lines of results (i.e., the three-factor model providing the best relative model fit, but these factors are not distinct from one another). To do so, we followed classical work on item parceling (e.g., Kishton & Widaman, 1994) and reduced the dimensionality of the data by combining the 20 DEX items to constitute three separate parcels that were equally representative of the cognitive, behavioral, and affective aspects of executive difficulties (as indicated in the three-factor model). The three parcels were: P1 = impaired abstract reasoning, impulsivity, euphoria, knowing-doing dissociation, poor decision-making, and no concern for social rules; P2 = confabulation, planning problems, apathy, restlessness, response-suppression problems, and distractability; and P3 = temporal sequencing problems, lack of insight,

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[1] We also explored whether second-order factor models would provide better model fit to our data. This was not the case (e.g., three-factor model in Study 1: $\chi^2=613$, df=186, CFI=.860, RMSEA=.070).
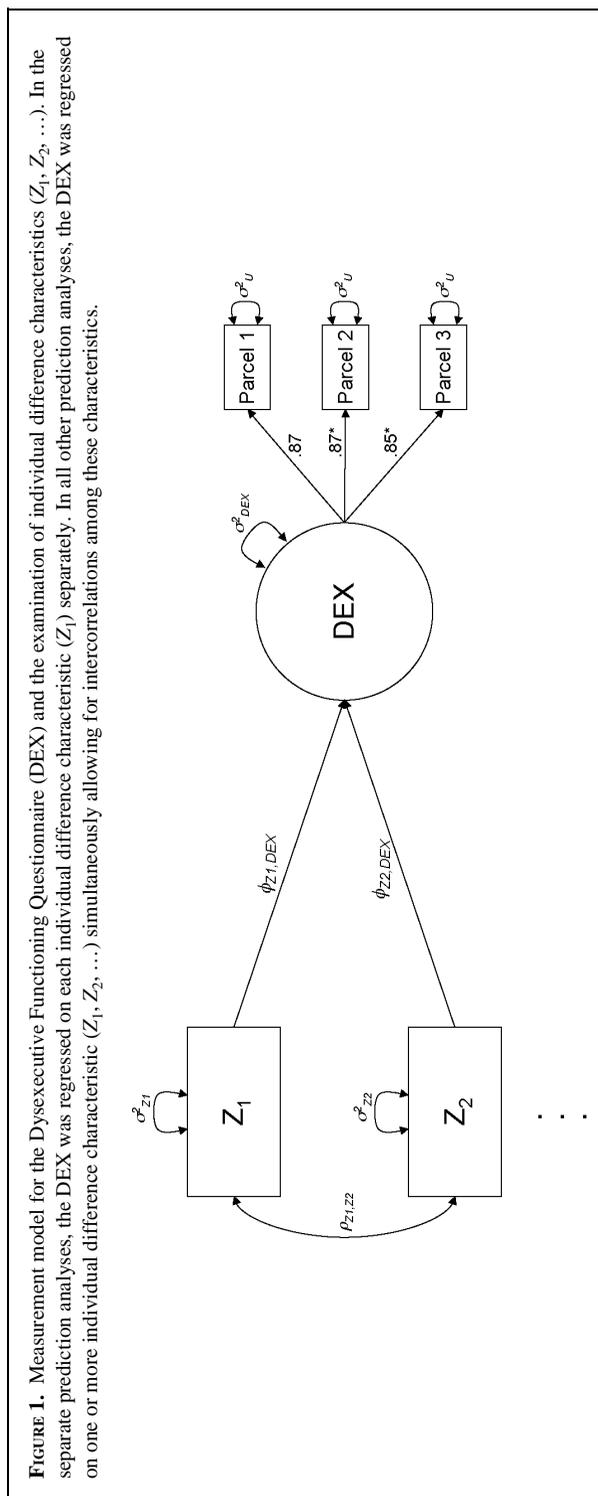
disinhibition, shallow affect, aggression, no concern for others' feelings, perse-veration, and no concern for social rules. A graphical representation of this measurement model of the DEX (and the examination of individual difference characteristics to be reported in a subsequent step) is presented in Figure 1, and Table 4 provides results of invariance analyses across age group and study (for details of the models, see footnote of Table 4). As can be obtained, the parsimoni-ous one-factor measurement model of the DEX provides excellent fit to the data of Study 1 (e.g., CFI close to 1.00), results in highly reliable indicators of the latent factor (i.e., all factor loadings were above .80), and evidence for metric invariance was found across the three age groups and the two studies (i.e., no significant loss in model fit when constraining factor loadings to be equal across age and study).

Frequency and Individual Difference Correlates of Everyday Executive Functioning Problems

Age Differences in the DEX

To examine the frequency of behavioral difficulties associated with execu-tive functioning in everyday life across various phases of adulthood, Figure 2 shows the number of dysexecutive problems (as indexed by the sum across all DEX items) reported by the three age groups of young, middle-aged, and older adults separately for the two studies. Given that the response format for the items ranged from 0 to 4 with the sum across all items varying between 0 and 80, all three age groups reported, on average, that they indeed experience such diffi-culties in their daily life (e.g., 18–39 year olds in Study 1: $M = 23.2$). Interest-ingly, younger participants reported more dysexecutive problems than did elderly participants. The average difference between the young and the old in the number of problems reported was 5.8 in Study 1, $F(1, 285) = 15.6, p < .01$, and 7.6 in Study 2, $F(1, 418) = 44.0, p < .01$. When expressed as effect sizes based on the between-person standard deviation of the young participants, these differences amount to 0.50 SD in Study 1 and 0.68 SD in Study 2. Similar effect sizes were found in follow-up analyses that restricted the group of the elderly to those above age 70 years [$n = 213$, in total: 0.60 SD, $F(1, 536) = 44.2, p < .01$] and above age 80 years [$n = 69$, in total: 0.43 SD, $F(1, 392) = 10.1, p < .01$], respectively, suggesting that these findings were not due to participants in their 60s but generalize to participants in their 70s and 80s.[2]

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[2] Follow-up analyses indicated that this pattern was not restricted to particular types of items despite the finding of a single underlying factor. For example, younger adults were found to report higher scores as compared to older adults on the sum of six items purported to reflect rather cognitive aspects of dysexecutive behaviors in the Wilson Model (1998): M=7.70, SE=0.24 vs. M=5.41, SE=0.23, $F(1, 705)$=45.80, $p < .01$. In addition, when we used a positive symptom count across the 20 DEX items (i.e., counting all items endorsed; range 0–20), we found a substantively similar pattern to that reported for the total score (young adults: M=13.10, SE=0.27; middle-aged adults: M=11.02, SE=0.26; older adults: M=9.86, SE=0.28; $F(2, 1870)$=33.15, $p < .01$).

FIGURE 1. Measurement model for the Dysexecutive Functioning Questionnaire (DEX) and the examination of individual difference characteristics (Z_1, Z_2, …). In the separate prediction analyses, the DEX was regressed on each individual difference characteristic (Z_i) separately. In all other prediction analyses, the DEX was regressed on one or more individual difference characteristic (Z_1, Z_2, …) simultaneously allowing for intercorrelations among these characteristics.

TABLE 4. Examination of factorial invariance of a one-factor model using three parcels of DEX items across three adult age groups in Study 1 and across Study 1 and Study 2
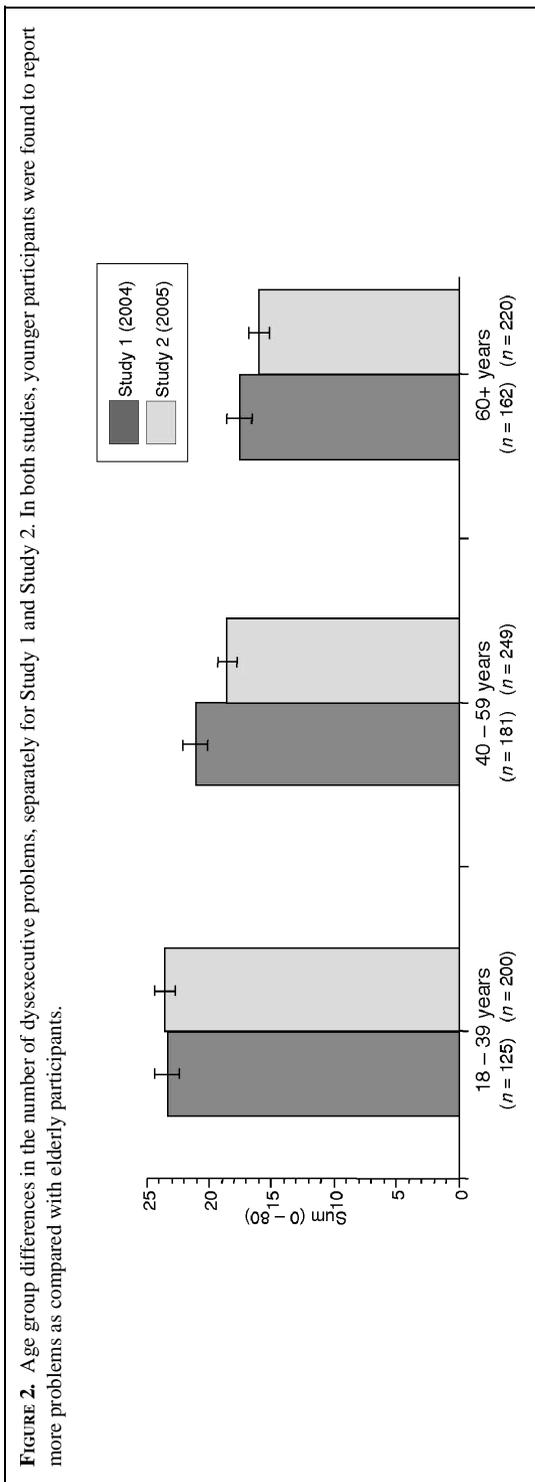
Model	Goodness of fit indices						
	χ^2	df	$\triangle \chi^2/df$	AIC	BIC	CFI	RMSEA
Age group invariance							
Configural	13	8	–	2,113	2,154	.994	.064
Metric	15	12	2/4	2,106	2,131	.997	.039
Study invariance							
Configural	13	5	–	5,110	5,145	.996	.053
Metric	13	7	0/2	5,106	5,131	.997	.038

Note. Study 1: 18–39 years, $N=125$; 40–59 years, $N=181$; 60+ years, $N=162$. Study 2: 18–39 years, $N=200$; 40–59 years, $N=249$; 60+ years, $N=220$. In the *age group configural invariance* model, the factor loading for parcel 1 was fixed to 1 for model identification purposes, leaving 12 parameters to be estimated (2 factor loadings × 3 age groups, 1 variance σ^2_{DEX} × 3 age groups, 1 unique variance σ^2_u). In the *age group metric invariance* model, all factor loadings were estimated to be equal across age groups, leaving six parameters to be estimated (2 factor loading, 1 variance σ^2_{DEX}×3 age groups, 1 unique variance σ^2_u). In the *study configural invariance* model, the factor loading for parcel 1 was fixed to 1 for model identification purposes, leaving seven parameters to be estimated (2 factor loadings × 2 study groups, 1 variance σ^2_{DEX}×2 study groups, 1 unique variance σ^2_u). In the *study metric invariance* model, all factor loadings were estimated to be equal across study groups, leaving five parameters to be estimated (2 factor loading, 1 variance σ^2_{DEX}×2 study groups, 1 unique variance σ^2_u). AIC, Akaike's Information Criterion; BIC, Bayesian Information Criterion; CFI, Comparative Fit Index; RMSEA, Root Mean Square Error of Approximation. *$p < .01$.

Individual Difference Correlates of the DEX

To explore associations between the DEX and a number of individual difference variables, we used the above findings of factorial invariance of the one-factor model to pool the data across age groups and studies, apply the well fitting structural model of the DEX (as indicated by three parcels), and regress the latent construct of the DEX onto each predictor (labeled *Z* in Figure 1). Although such a procedure is similar to a series of regression analyses using a simple aggregate score for the DEX, it offers the advantage of correcting for measurement error in the DEX. To determine shared and unique associations of these predictors as well as potential age differences, Table 5 shows results from separate and simultaneous prediction analyses of all predictors that allowed for intercorrelations among them (see Figure 1 for Z_1, Z_2, etc.).

As indicated in column 2 of Table 5, individual differences in the DEX were related to almost all of the variables examined when separate prediction analyses considered these variables on their own. Specifically, levels of dysexecutive problems reported were negatively associated with age, being a woman, years of education, performance on the MMSE and a vocabulary test as well as subjective health and positive affect. Positive associations of

FIGURE 2. Age group differences in the number of dysexecutive problems, separately for Study 1 and Study 2. In both studies, younger participants were found to report more problems as compared with elderly participants.

TABLE 5. Standardized regression coefficients from separate and simultaneous latent construct analyses of individual difference variables and the DEX Questionnaire

	Separate analyses			Simultaneous analyses	
Variable	Step 1: zero-order β	Step 2: age-partialed β	Step 3: age×variable β	Variable β	Age×variable β
Age	− .22*	–	–	− .11*	–
Gender	− .12*	− .12*	.02	− .15*	–
Education	− .16*	− .16*	.50*	− .03	.03
MMSE	− .12*	− .17*	− .11*	− .08	− .12*
Trait anxiety	.55*	.52*	.09*	.30*	.09
Subjective health	− .19*	− .24*	− .05	.06	–
Depression	.52*	.49*	.08*	.17*	− .02
Positive affect	− .24*	− .20*	− .07	− .03	–
Negative affect	.38*	.36*	.08*	.10*	.03
Neuroticism	.22*	.20*	.00	.05	–
Digit Symbol	.01	− .18*	− .07	− .01	–
Vocabulary	− .14*	− .13*	− .05	− .02	–

Note. *N*=1,137. MMSE, Mini-Mental State Examination. For gender, men=0, women =1. Step 1= Regression of the DEX measure on each variable separately. Step 2=Regression of the DEX measure on each variable separately and on age. Step 3=Regression of the DEX measure on each variable separately, on age, and on an interaction term of the variable with age. Significant interactions between age and a given variable indicate stronger associations in the elderly.
*p < .01.

the DEX were found with levels of trait anxiety, depression, negative affect, and neuroticism. The amount of variance accounted for in the DEX ranged between 30% for trait anxiety and 1% for the MMSE. Column 3 of Table 5 denotes that all of these associations remained statistically significant when age was used as an additional predictor. In addition, these age-partialed analyses suggested that performance on the Digit Symbol test was also negatively related to the number of dysexecutive problems once age was taken into account. In a final step of the separate analyses, column 4 of Table 5 reports analyses when in addition to the main effects of a given variable and age, interaction terms with age were added. As can be seen, statistically significant interactions with age were found for years of education, the MMSE, trait anxiety, depression, and negative affect. Follow-up analyses suggested that the DEX showed stronger associations with these variables among the elderly as compared with younger participants.

Given that some of the individual difference variables conceptually over-lap (e.g., anxiety and negative affect: Watson & Clark, 1992), we were also interested in the unique associations of the variables with the DEX. In a simultaneous analysis, we thus utilized all 12 individual difference characteristics

plus the five statistically significant interactions as predictors of the DEX. Columns 5 and 6 of Table 5 indicate that age, gender, trait anxiety, depression, and negative affect as well as the age interaction with the MMSE were found to remain statistically significant. Specifically, the negative age association of the DEX was less pronounced ($\beta=-.11$, $p < .01$) as compared with the zero-order model ($\beta=-.22$, $p < .01$), and negative affect variables were found to show the strongest unique relations to the DEX (e.g., trait anxiety: $\beta=.30$, $p < .01$). That is, individuals who reported more unpleasant affect also tended to report more dysexecutive problems in their everyday life. Following-up on the interaction between MMSE and age, results revealed that the cognitively less fit elderly (MMSE ≤ 27; $n=85$) reported significantly more dysexecutive problems (indexed by the sum across all DEX items: $M=20.48$, $SE=1.71$) than the cognitively fit elderly (MMSE > 27; $n=243$; $M=15.20$, $SE=0.68$), $F(1, 324)=11.84$, $p < .01$.[3]
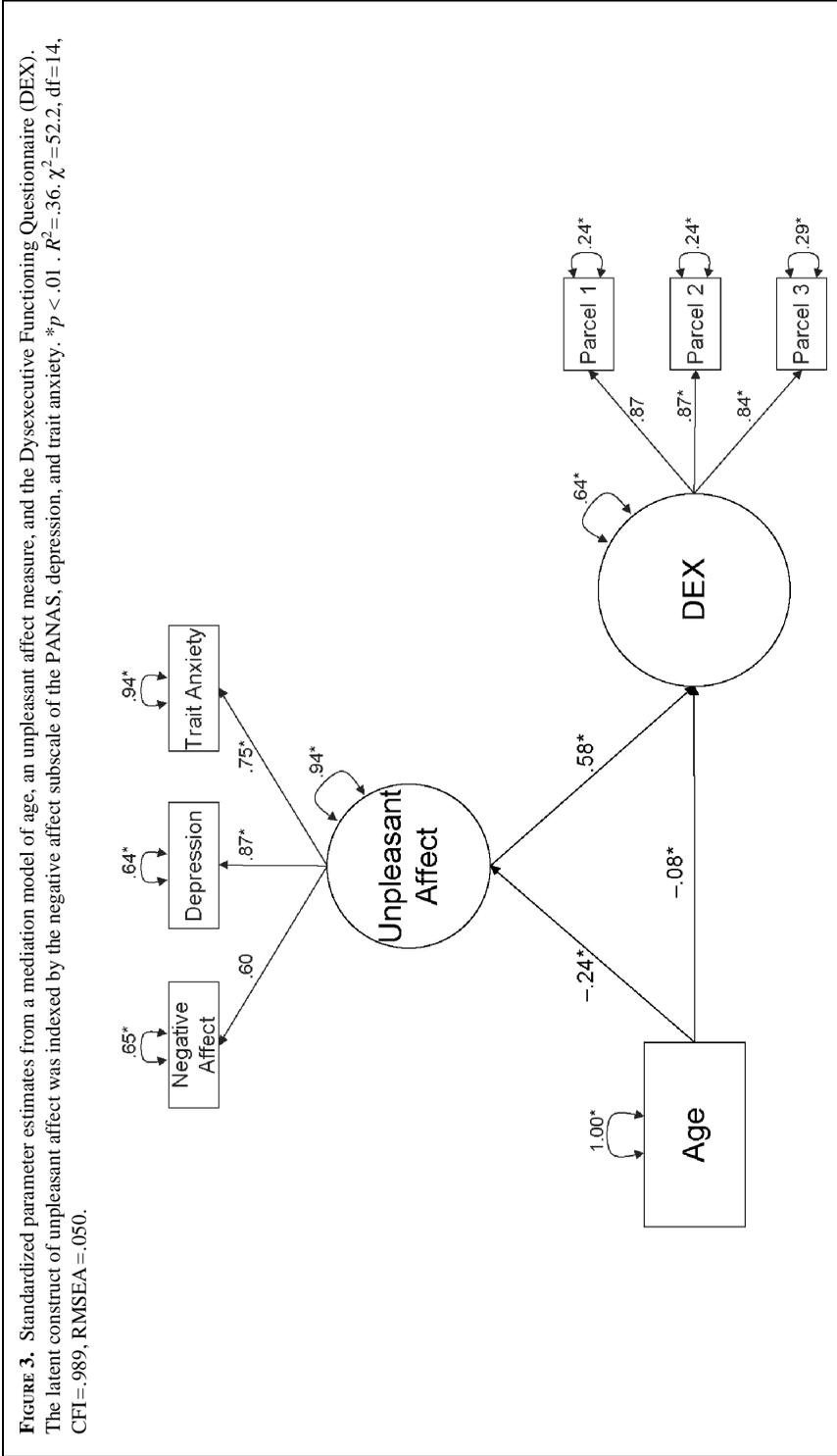
Informed by the above findings of less pronounced age associations of reporting executive problems in the simultaneous analyses of all predictor variables, we finally employed a mediation model exploring whether an unpleasant affect factor partially mediated the age associations of the DEX. Data from both studies were pooled together for this set of analyses. Figure 3 provides a graphical representation of the model applied (with standardized parameter estimates), which included age and latent constructs of the DEX and unpleasant affect, as indexed by the negative affect subscale of the PANAS, depression, and trait anxiety. It can be seen that age related negatively to unpleasant affect ($\beta=-.24$, $p < .01$), which itself had a strong positive prediction effect for differences in the DEX ($\beta=.58$, $p < .01$). At the same time, the direct effect of age on the DEX is reduced to $\beta=-.08$ ($p < .01$) suggesting that unpleasant affect variables largely mediated the age differences seen in reports of executive dysfunctions (mediated effect: $\beta=-.14$).

DISCUSSION

The major objectives of the current study were to examine the nature and functional implications of self-reported executive dysfunctions in everyday life across adulthood and old age. Our results, based on analyses of data from two moderately large samples of community-dwelling adults, indicated that the underlying factor structure of the Dysexecutive Questionnaire

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[3] Note that information for the MMSE was missing for $n=54$. We acknowledge that a cut-off of 27 on the MMSE is higher than those used in clinical research and practice, and also that such a procedure implicitly assumes discontinuity of individual differences in cognitive functioning. However, using this cut-off results in reasonable statistical power (assured by group sizes), and we corroborated the general pattern of results when using the MMSE as a continuous variable and included the MMSE by variable interaction terms in the prediction of the DEX among 60+ year olds.

FIGURE 3. Standardized parameter estimates from a mediation model of age, an unpleasant affect measure, and the Dysexecutive Functioning Questionnaire (DEX). The latent construct of unpleasant affect was indexed by the negative affect subscale of the PANAS, depression, and trait anxiety. *$p < .01$. $R^2 = .36$. $\chi^2 = 52.2$, df = 14, CFI = .989, RMSEA = .050.

(DEX) could parsimoniously be described by a one-factor model that was found invariant across the adult age range as well as across studies. Findings also indicated that community-dwelling adults indeed experience executive problems in their everyday lives. Although executive functions are known to decline with advancing adult age, younger age groups reported more difficulties than older age groups. In addition, individual differences in reports of dysexecutive behaviors were related to various individual difference characteristics including gender, education, health, affect, personality, and cognitive functioning. We also found evidence suggesting that negative affect variables partially mediated the negative age associations of the DEX. Our discussion attempts to integrate our findings into the extant literature and considers implications for the validity of the DEX instrument as well as for future research on self-reported executive dysfunctioning.

Factor Structure of the Dysexecutive Questionnaire

Previous research on the factor structure of the DEX both in clinical and non-clinical samples has revealed evidence for multiple underlying factors (Amevia et al., 2003; Burgess et al., 1998; Mooney et al., 2006; Wilson et al., 1998). However, these reports differ in whether they suggest a three-, a four- or a five-factor structure to best describe the data. Such inconsistencies may be due to differences in sampling characteristics as well as using self- or informant-reports, or the age range of the sample considered. In the present study, we have used self-report data from two moderately large independent samples of community-dwelling adults across the entire adult age range. Proceeding in a confirmatory manner and using a thorough direct empirical comparison of several factor models derived from previous studies, our results indicate that indeed a three-factor solution of cognitive, behavioral, and affective components as reported by Wilson and colleagues (1998) provided the relatively best model fit. However, extraordinarily high factor intercorrelations lead us to question the validity and uniqueness of these factors. Instead, a one-factor model constructed from parcels that equally reflected these three factors was found to provide not only the most parsimonious factor solution, but also resulted in good model fit in absolute terms.

A major new finding of our study is that the one-factor model could be set invariant across independent studies and various age groups. This suggests that we have found convergent evidence across two samples that various aspects of self-reported everyday executive problems as assessed by the DEX can effectively be summarized using one overall score. In addition, reports of executive functioning deficits among young, middle-aged, and older adults could be described with the same structural model. To further examine the nature and functional implications of reporting executive problems, this finding allowed for a direct empirical examination of age-related

differences in the frequencies of reported dysexecutive behaviors and their relation with individual difference characteristics in subsequent steps.

Frequency and Individual Difference Correlates of Everyday Executive Functioning Problems

Given the primary focus on clinical samples in the extant literature (Burgess et al., 1998; Wilson et al., 1998), it was largely an open question how often people experience instances of executive dysfunctions in everyday life. To the best of our knowledge, this project represents the first study of self-reported executive functioning difficulties in everyday life based on moderately large cross-sectional samples that span the entire adult age range. Findings from this study provide evidence that executive functioning difficulties such as sub-jective impressions of poor decision-making, distractability, or planning prob-lems appear to be of sizeable frequency in everyday life throughout the adult age range. Our results are in line with evidence from a relatively small middle-aged Chinese sample (Chan, 2001) and highlight that executive dysfunction can be observed in daily life routine and over-learnt tasks. This interpretation is also underscored by the moderately high stability of such reports over a 1-year period that was available for a subset of participants ($n=89$, $r_{T1,T2}$ of sum scores$=.66$). We acknowledge that, in contrast to clinical groups, these difficul-ties may not have the potential to disrupt one's everyday life completely. Following Chan (2001), such difficulties may thus be referred to as represent-ing absentmindedness or some personality facet (see also Reason, 1984).

Reports of executive dysfunctions in everyday life were also associated with a number of the individual difference variables examined. Considering these correlates separately, more executive difficulties were primarily related to less desirable characteristics such as depression, anxiety, neuroticism, less subjective health, fewer positive affect or lower cognitive performance. In addition, men were found to report more difficulties than women, and some of the DEX-correlate associations were more pronounced among the elderly, which may speak to a larger overlap of underlying sources of functioning during later adulthood. When considering unique associations in simulta-neous analyses, reports of dysexecutive behaviors were primarily associated with measures geared towards assessing various aspects of unpleasant or neg-ative affect. This suggests that affective experiences associated with execu-tive dysfunctions appear to be well captured by the DEX. However, only a few unique associations with measures of cognitive functioning were found (i.e., compromised cognitive fitness among the elderly, as indexed by the MMSE). Such weak associations between reports of executive dysfunctions and psychometric tests of cognitive abilities are in line with previous reports (Chan, 2001; Shallice & Burgess, 1991; see also Rabbitt, 1997), but of course leave questions unanswered regarding the validity of the DEX in normal populations to directly capture executive dysfunctions.

Of particular interest were age-related differences in the frequency of experiencing everyday executive functioning problems. Younger participants reported more dysexecutive problems on average than did elderly participants, and these differences correspond to a medium effect size (Cohen, 1988) in that they amounted to about half a standard deviation when expressed as effect sizes based on between-person differences of young participants. We also note that these age group differences remained virtually unchanged when we considered subsets of items reflecting cognitive, behavioral, or affective-motivational aspects only (as suggested by Wilson et al., 1998). This finding was surprising given that older adults typically show lower performance on measures relevant to executive functioning (Salthouse, Atkinson, & Berish, 2003). At the same time, however, fewer reported executive functioning problems in the elderly parallel findings of better emotion regulation with age (Carstensen et al., 2000; Lawton et al., 1993; Mroczek & Kolarz, 1998; Roecke, 2006). That is, older adults experience negative emotions less frequently than their younger counterparts either because they handle emotionally challenging situations better or because they manage to avoid such situations. Such an interpretation is in line with our finding that unpleasant affect variables were the prime factor involved in the reduction with age in the frequency of reported executive problems. In other words, young adults reported more executive problems, in part, because they experienced higher levels of negative affect, and as negative affect decreases with age (see also Table 1 for the negative age correlations) so does the number of reported executive functioning problems.

Taken together, these findings raise questions about the validity of the DEX questionnaire in the context of community-dwelling adults. It seems as if the instrument does not tap directly tap into executive functioning, but rather indexes aspects of unpleasant affect that may accompany the experience of everyday executive functioning problems. In addition, although we have found sizeable frequencies of endorsing executive problems in everyday life, we cannot rule out the possibility of under-reporting such difficulties among community-dwelling adults, as has been reported in clinical subpopulations (Burgess et al., 1998). For example, Salthouse and Siedlecki (2005) reported that measures on divided attention tasks performed in the lab did not correlate with self-reports of divided attention ability. We thus acknowledge that participants may not always be accurate in their judgments of how well they perform in cognitively demanding situations and such inaccuracy (or under-reports) may be more pronounced in old age (Hertzog & Hultsch, 2000). Alternatively, it may also be that the positive selection of our sample (e.g., average scores on cognitive measures were above the age-adjusted norms) may have resulted in underestimating the amount of troubles experienced by older adults.

Limitations and Outlook

The present study has shed light on the nature and functional implications of self-reported executive functioning problems in everyday life across the adult age range, as measured by the DEX instrument. However, we acknowledge several limitations of this study. To begin with, our only evidence for DEX-cognition associations was that cognitively less fit elderly reported substantially more dysexecutive problems than the cognitively fit elderly. It may well be that the DEX could thus be useful as a supplementary screening instrument to identify community-dwelling elderly who are living independently, but who are at risk for developing impairments in their capacity to manage the challenges of everyday living. Before conclusive statements can be made, however, future research should closely examine associations of the DEX with measures considered to index executive functioning, which were not available in our study. This would also allow for more thoroughly decomposing the cognitive and affective components involved in reports of executive difficulties, and thereby examine whether the DEX largely reflects aspects of emotion regulation rather than more conventional aspects of executive functioning.

One further limitation is that the cross-sectional nature of our data did not allow a direct examination of age-related changes as well as potential precursors and consequences of executive difficulties in daily life. Future research may also benefit from examining dysexecutive functioning problems in an everyday context. Specifically, time-sampling assessment procedures may be instructive to better understand the characteristics of situations that bring about such difficulties and thereby provide possibilities for interventions. For example, such a line of inquiry may inform us whether unpleasant affect prompts people to experience executive problems or whether executive problems are a leading indicator of unpleasant affect. In sum, the current study has offered initial insights into factors underlying, the frequency, and potential implications of everyday executive functioning deficits, but a number of interesting questions remain.

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REFERENCES

Amevia, H., Phillips, L., & Sala, S. D. (2003). Behavioral dysexecutive symptoms in normal aging. *Brain & Cognition, 53,* 129–132.

Baddeley, A. D. (1990). *Human memory: Theory and practice*. Hove, UK: Erlbaum.

Baltes, P. B., & Baltes, M. M. (Eds) (1990). *Successful aging: Perspectives from the behavioral sciences*. New York: Cambridge University Press.

Burgess, P. W., Alderman, N., Evans, J., Emslie, H., & Wilson, B. A. (1998). The ecological validity of tests of executive function. *Journal of the International Neuropsychological Society, 4*, 547–558.

Chan, R. C. K. (2001). Dysexecutive symptoms among a non-clinical sample: A study with the use of the Dysexecutive Questionnaire. *British Journal of Psychology, 92*, 551–565.

Carstensen, L. L., Pasupathi, M., Mayr, U., & Nesselroade, J. R. (2000). Emotional experience in everyday life across the adult life span. *Journal of Personality and Social Psychology, 79*, 644–655.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Mahwah, NJ: Erlbaum.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini Mental State: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*, 189–198.

Gold, D. P., & Arbuckle, T. Y. (1990). Interactions between personality and cognition and their implications for theories of aging. In E. A. Lovelace (Ed.), *Aging and cognition: Mental processes, self-awareness, and interventions* (pp. 351–377). Amsterdam, The Netherlands: North-Holland.

Goldberg, L. R. (1999). A broad-band, public domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, I. Deary, F. De Fruyt, & F. Ostendorf (Eds.), *Personality psychology in Europe* (Vol. 7, pp. 7–28). Tilburg, The Netherlands: Tilburg University Press.

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

Kishton, J. M., & Widaman, K. F. (1994). Unidimensional versus domain representative parceling of questionnaire items: An empirical example. *Educational and Psychological Meausrement, 54*, 757–765.

Lawton, M. P. (1983). Environment and other determinants of well-being in older people. *Gerontologist, 23*, 349–357.

Lawton, M. P., Kleban, M. H., & Dean, J. (1993). Affect and age: Cross-sectional comparisons of structure and prevalence. *Psychology and Aging, 8*, 165–175.

Lindenberger, U., & Baltes, P. B. (1997). Intellectual functioning in old and very old age: Cross-sectional results from the Berlin Aging Study. *Psychology and Aging*, *12*, 410–432.

Malloy, P., & Grace, J. (2005). A review of rating scales for measuring behavior change due to frontal systems change. *Cognitive and Behavioral Neurology, 18*, 18–27.

Mooney, B., Walmsley, C., & McFarland, K. (2006). Factor analysis of the self-report Dysexecutive (DEX-S) Questionnaire. *Applied Neuropsychology*, *13*, 12–18.

Mroczek, D., & Kolarz, C. M. (1998). The effect of age on positive and negative affect: A developmental perspective on happiness. *Journal of Personality and Social Psychology, 75,* 1333–1349.

Muthén, L. K., & Muthén, B. O. (1998). *Mplus, the comprehensive modeling program for applied researchers user's guide*. Los Angeles, CA: Author.

Parkin, A. J. (1998). The central executive does not exist. *Journal of the International Neuropsychological Society, 4*, 518–522.

Rabbitt, P. (Ed.). (1997). *Methodology of frontal and executive function*. Hove, UK: Psychology Press.

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*, 385–401.

Reason, J. (1993). Self-report questionnaires in cognitive psychology: Have they delivered the goods? In Baddeley, A., & Weiskrantz, L. (Eds.), *Attention: Selection, awareness, and control – A tribute to Donald Broadbent* (pp. 406–423). Oxford, UK: Clarendon.

Reason, J. (1984). Lapses of attention in everyday life. In Parasuraman, R., & Davies, D. R. (Eds.), *Varieties of attention* (pp. 515–549). London: Academic Press.

Roecke, C. (2006). *Intraindividual variability in positive and negative affect: Age-related and individual differences in magnitude and coupling with cognitive performance*. Doctoral dissertation. Free University Berlin, http://www.diss.fu-berlin.de/2006/669/indexe.html.

Rowe, J. W., & Kahn, R. L. (1997). Successful aging. *Gerontologist, 37*, 433–440.

Ryff, C. D., & Singer, B. (1998). The contours of positive human health. *Psychological Inquiry, 9*, 1–28.

Salthouse, T. A. (2004). What and when of cognitive aging. *Current Directions in Psychological Science, 13*, 140–144.

Salthouse, T. A. (in press). Executive functioning. In D. C. Park & N. Schwarz (Eds.), *Cognitive aging: A primer*. New York: Psychology Press.

Salthouse, T. A., & Siedlecki, K. L. (2005). Reliability and validity of the Divided Attention Questionnaire. *Aging, Neuropsychology, and Cognition, 12*, 89–98.

Salthouse, T. A., Atkinson, T. M., & Berish, D. E. (2003). Executive functioning as a potential mediator of age-related cognitive decline in normal adults. *Journal of Experimental Psychology: General*, *132*, 566–594.

Salthouse, T. A., Siedlecki, K. L., & Krueger, L. E. (2006). An individual differences analysis of memory control. *Journal of Memory and Language*, *55*, 102–125.

Schaie, K. W. (2005). *Developmental influences on intelligence: The Seattle Longitudinal Study*. New York: Oxford University Press.

Schwartz, M. F. (1995). Re-examining the role of executive functions in routine action production. *Annals of the New York Academy of Sciences, 769,* 321–335.

Shallice, T., & Burgess, P. W. (1991). Deficits in strategy applications following frontal lobe damage in man. *Brain, 114,* 727–741.

Spielberger, C., Gorsuch, R., Lushene, R., Vagg, P., & Jacobs, G. (1983). *Manual for the State-Trait Anxiety Inventory (Form Y)*. Palo Alto, CA: Consulting Psychologists Press.

Stuss, D. T., & Benson, D. F. (1984). Neuropsychological studies of the frontal lobes. *Psychological Bulletin*, *95*, 3–28.

Stuss, D. T., & Benson, D. F. (1986). *The frontal lobes*. New York: Raven.

Watson D., & Clark, L. A. (1992). On traits and temperament: General and specific factors of emotional experience and their relation to the five-factor model. *Journal of Personality, 60*, 441–476.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063–1070.

Wechsler, D. (1997). *Wechsler Adult Intelligence Scale—Third Edition.* San Antonio, TX: The Psychological Corporation.

Wilson, B. A., Alderman, N., Burgess, P. W., Emslie, H., & Evans, J. J. (1996). *Behavioral Assessment of the Dysexecutive Syndrome*. Bury St. Edmund, UK: Thames Valley Test Company.

Wilson, B. A., Evans, J. J., Emslie, H., Alderman, N., & Burgess, P. (1998). The development of an ecologically valid test for assessing patients with a dysexecutive syndrome. *Neuropsychological Rehabilitation, 8,* 213–228.