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Reduced Lexical Access to Verbs in Individuals With Subjective Cognitive Decline

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Abstract

The detection of cognitive impairment in individuals with subjective cognitive decline (SCD) may improve detection of the emergence of Alzheimer's disease (AD) pathology. This detection is challenging, however, given the lack of sensitive assessment tools. The main objective of this study was to determine the potential contribution of word production tasks to the detection of cognitive impairment in SCD. The performances of 20 individuals with SCD, healthy controls (HCs), and individuals with mild cognitive impairment (MCI) were compared on object and action naming and free fluency tasks. Participants with SCD performed similarly to HCs, while both groups differed significantly from participants with MCI in object naming and object fluency. Results showed that participants with SCD were at the midpoint between HCs and participants with MCI in action naming. They also revealed a HCs > SCD = MCI pattern in action fluency. This study provides evidence that verb production is impaired in SCD and that SCD is a pre-MCI condition.

Keywords

subjective cognitive decline, Alzheimer's disease, action naming, action fluency, language, early detection

Introduction

Early detection of neurodegenerative diseases is a critical issue for health services as well as for clinical research related to the prevention of dementia. Alzheimer's disease (AD) and other major forms of dementia develop gradually and many studies have shown that their presymptomatic phases could extend over several decades.[1] According to the US National Institute on Aging-Alzheimer's Association,[2-4] AD progresses over 3 distinct stages: (1) preclinical stage of AD at which individuals can be placed on a continuum ranging from completely asymptomatic to a very subtle decline, along with biomarker evidence for AD; (2) mild cognitive impairment (MCI), which is the symptomatic predementia stage of AD, characterized by impairment in memory or other domains of cognition on a standard assessment and biomarker evidence for AD; and (3) dementia due to AD. Sperling et al[2] also suggested that the preclinical stage of AD itself represents a continuum ranging from the stage of "asymptomatic cerebral amyloidosis," at which individuals show biomarker evidence for AD but no detectable cognitive impairment, to the stage at which biomarker evidence is accompanied by a subtle cognitive decline.

Cognitive impairment associated with MCI and the dementia stages of AD progression can be identified using standardized neuropsychological tests. However, at the preclinical stage, the detection of cognitive deficits is much more challenging, due to the lack of sensitivity of assessment tools and due to compensatory mechanisms enabling individuals to normalize their performance.[5] In the late preclinical stages of AD, individuals frequently self-report subtle cognitive decline, referred to as "subjective cognitive decline" (SCD). Although "subjective," SCD is not trivial since numerous studies have suggested that self-reporting subtle cognitive problems is associated with increased likelihood of actual cognitive decline and AD dementia.[6-8] Moreover, according to a recent meta-analysis, approximately 27% and 14% of individuals with SCD will develop MCI and dementia, respectively, which is double the risk of dementia compared to older adults without cognitive complaints.[9]

Therefore, the objectification of cognitive impairment as well as greater consideration of self-reported cognitive decline in individuals with SCD could have the potential to improve the detection of the first effects of AD pathology. To date, this objectification is far from being conclusive. A few studies reported only slight cognitive impairment on cognitive tests in SCD. Compared to healthy controls (HCs), individuals with subjective memory impairment displayed impaired

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performance on delayed recall on a verbal episodic memory test.[10] Koppara et al[11] showed that the performance of participants with SCD, unimpaired in traditional neuropsychological testing, differed slightly from that of HCs in a visual short-term memory binding task (ie, detection of changes among shapes and colors). Participants with SCD also performed significantly worse than HCs on a long-term prospective memory test in which they had to remember to perform specific actions at specific times.[12] More recently, impairment of associative memory, assessed with a Face-Name Associative Recognition Test, was reported in 32 individuals with SCD, as compared to 28 HCs.[13]

In a few studies, authors used lexical access tasks to compare the performance of participants with SCD to that of HCs and participants with MCI and AD. Benito-León et al[14] studied cognitive function in older people in a large population-based elderly Spanish cohort and found that, compared to HCs, individuals with memory complaints showed poor semantic fluency and poor immediate and delayed recall. Similarly, low performances in semantic fluency tasks were evidenced 9 years before the clinical diagnosis of AD in a large sample of 1050 individuals without dementia.[15] Using various verbal fluency tests, Nutter-Upham et al[16] reported a continuum of performance in which HCs performed better than participants with SCD, who in turn performed better than participants with MCI. However, the difference between HCs and participants with SCD was not statistically significant. Lopez-Higes et al[17] showed that the performance of HCs was significantly better than that of participants with SCD in picture naming assessed with the Boston Naming Test[18] as well as in orthographic and semantic verbal fluency. However, both groups obtained similar results in sentence comprehension. Also using fluency tasks, including action fluency (ie, naming as many verbs as possible), Östberg et al[19] found significant differences between participants with SCD, MCI, and AD. In that study, participants with SCD performed within the normal range, but since there was no control group, it could not be verified whether their scores were lower than HCs. The authors also suggested that action fluency was the most useful task to discriminate MCI from the other 2 groups. Finally, very recently, Nikolai et al[20] showed that, compared to HCs, participants with SCD generated significantly fewer words in semantic fluency (vegetables), but not in orthographic fluency tasks.

The impairment of verb production, compared to noun production, has been demonstrated in numerous studies conducted with individuals with various neurological disorders. In neurodegenerative diseases, this impairment was reported in the nonfluent variant of primary progressive aphasia,[21] the behavioral variant of frontotemporal dementia,[22] corticobasal syndrome,[22] progressive supranuclear palsy,[22] amyotrophic lateral sclerosis,[23] Parkinson disease,[24,25] and AD.[26,27] With respect to action fluency, a few studies also showed the clinical relevance of verb fluency in the differential diagnosis of Parkinson disease with and without dementia,[28] AD and Parkinson disease,[29] AD and frontotemporal dementia,[30] and AD and Lewy body dementia.[31] In studies comparing object and action word production, both young and elderly participants found action naming more difficult than object naming in terms of accuracy and latencies.[27,32] Therefore, the additional complexity of action word processing, which is due to linguistic (morphological and syntactic complexity), semantic (differential organization of object and action concepts), and processing load differences, is more likely to cause lexical access difficulties in individuals with SCD than object word production.

In this study, differential access to nouns and verbs was investigated in HCs and participants with SCD and MCI using naming and verbal fluency tasks. The main objective was to determine the potential contribution of word production tasks to the detection of actual cognitive impairment in SCD and, more specifically, of verb compared to noun production. A secondary objective was to identify cognitive correlates (ie, executive functions, attentional control, and depression) of performance on naming and verbal fluency tasks in SCD. This objective was driven by different issues. First, fluency tasks are known to rely heavily on executive functions and attentional control, whose role is to monitor and track working memory representations, flexibly shift between mental sets, and inhibit dominant responses.[33] In addition, action fluency was shown to be a test that more particularly involves executive functioning and attentional control.[28,34] In word naming, the greater difficulty with verbs was also attributed to their greater reliance than nouns on executive functions and attentional control.[35] Second, SCD is associated with depression[36] whose influence on cognitive performance is commonly accepted, especially when tasks are cognitively demanding.[37] Depression is known to affect performance on verbal fluency tasks, although the origin of the impairment (executive functions vs a more generalized cognitive deficit) remains unclear.[38]

Methods

Recruitment of Participants

Participants in this study included 20 older adults with SCD, 20 adults with MCI, and 20 HCs. All participants were aged 50 years or older (range: 51-80 years). Participants with SCD or MCI were referred to the research team by clinicians or were recruited through advertisements in medical clinics. The participants with SCD were all worried about their memory. They met the criteria for SCD as defined by Jessen et al[5]: (1) self-experienced persistent decline in cognitive capacity in comparison with a previously normal status and unrelated to an acute event (SCD was assessed with the *Questionnaire de Dépistage de la Plainte Cognitive* ("Screening Questionnaire of Cognitive Complaint"—SQCC; Dion et al. Unpublished data and (2) normal age-, gender-, and education-adjusted performance on standardized cognitive tests. Participants with MCI met the clinical criteria detailed by Albert et al[3]: (1) cognitive concern reflecting a change in cognition reported by the patient, an informant, or the clinician (ie, historical or observed evidence of decline over time); (2) objective evidence of impairment (more than −1.0 standard deviation [SD] based on normative

data for age, sex, and education) in one or more cognitive domains, including memory test de rappel libre/rappel indicé à 16 items "16-item free and cued recall"[39]; (3) no significant impairment in functional abilities, based on clinical consensus and the Alzheimer's Disease Cooperative Study-Activities of Daily Living (ADCS-ADL)[40]; and (4) not demented.

Healthy controls were recruited by the research team through advertisements in local newspapers. They were all in good physical and mental health, did not report any significant subjective cognitive complaints (see Clinical Assessment and Group Characterization section for a description of the criteria) on the SQCC, and had normal cognitive performance (less than −1.0 SD) on standardized neuropsychological tests. All participants spoke French as their primary language.

Exclusion criteria for all participants were (1) history of moderate or severe traumatic brain injury, (2) history of cerebrovascular disease, (3) history of delirium (in the last 6 months), (4) history of intracranial surgery, (5) history of neurological disorder of cerebral origin (other than those examined in the study), (6) history of encephalitis or bacterial meningitis, (7) unstable metabolic or medical condition (eg, untreated hypothyroidism or diabetes), (8) history or actual diagnosis of a psychiatric disorder according to the *DSM-V* (Axis I),[41] (9) oncological treatments in the last 12 months, (10) general anesthesia in the last 6 months, (11) alcoholism or substance abuse (in the last 12 months), (12) uncorrected vision or hearing problems, (13) use of experimental medication, and (14) inability of the participant to provide informed consent. The absence of exclusion criteria was self-reported and, when possible, verified from the medical file.

Written informed consent was obtained at the beginning of the study, in accordance with the Declaration of Helsinki. The study was approved by the Research Ethics Board of the *Institut universitaire en santé mentale de Québec* (#220-2009).

Clinical Assessment and Group Characterization

All participants were administered a comprehensive battery of clinical and neuropsychological tests to verify the inclusion/exclusion criteria and to characterize the groups. The battery included measures of cognitive complaints (SQCC), depressive symptoms (Geriatric Depression Scale [GDS]),[42] independence in daily living activities (French adaptation of the ADCS-ADL for MCI),[40] general cognitive status,[43, 44] episodic memory,[39,45] executive functions,[46-48] confrontation naming,[49,50] orthographic (T-N-P) and semantic (animals) verbal fluency,[51] semantic memory,[52,53] visuoperception, and visuoconstructive abilities.[54,55] For all neuropsychological tests, age-stratified (or age, sex, and education stratified when available) norms were used.

The SQCC aimed to distinguish participants with probable pathological-related cognitive complaints from HCs. This in-house and standardized questionnaire is based directly on Jessen et al's research criteria for SCD. It comprises 5 short questions aiming at identifying (1) concerns about memory functioning, (2) feelings that memory is not as good as for people of the same age, (3) estimation of one's lifetime memory level compared to people of the same age, (4a) feelings that memory level has changed compared to past functioning, (4b) personal estimation of the period from which memory has declined, and (5) feelings that memory declines faster than people of the same age. Participants with normal cognitive functioning who thought that their memory was better than or similar to (only if it did not represent a decline) that of people of the same age were assigned to the control group, as well as those who reported poorer memory functioning but for which no decline was reported over the past 10 years. Participants reporting poorer memory functioning than people of the same age (or similar if they once thought it was superior) and a decline over the past 10 years were assigned to the SCD group if they had neither cognitive impairment nor major depression. Finally, participants were included in the MCI group if they had cognitive deficits without major depression.

Demographic data and results on clinical and neuropsychological tests are shown in Table 1. A multivariate analysis of variance (MANOVA) was conducted with demographic data (age and level of education) and score on neuropsychological tests as independent variables and the groups as dependent variables. Pairwise comparisons were made using Bonferroni post hoc analysis. The participants' average age was 69.4 (SD = 6.7) years and the average level of education was 14.8 (SD = 3.0) years. As shown in Table 1, MCI and HCs were equivalent with respect to age and level of education, while SCD was statistically younger than MCI and more educated than MCI. As expected, participants with SCD and MCI expressed more cognitive complaints than HCs. No participant was clinically depressed or scored in the depressed range on the GDS. Compared to HCs and SCD, MCI scored lower on the ADCS-ADL, although still within the normal range. They also had lower scores than HCs and SCD on the Montreal Cognitive Assessment (MoCA), although the difference between the 3 groups was not significant. With respect to cognitive functions, MCI only showed significant deficits on tests assessing episodic memory (16-item free and cued recall), executive functions (number–letter alternate sequencing; clock drawing test), confrontation naming, and verbal fluency.

Experimental Tasks

Participants in all 3 groups were administered 2 naming tasks and 2 free verbal fluency tasks. The 2 fluency tasks were administered, first before the naming tasks, to avoid giving cues through the object pictures and action videos.

Naming Tasks

Naming abilities were assessed with an object naming task and an action video naming task. The object naming task comprised 60 color pictures (30 natural concepts and 30 man-made concepts) selected from the Rossion and Pourtois[56] set. The 30 pictures corresponding to natural concepts (animals = 16; fruits and vegetables = 10; body parts = 3; nature = 1) were

Table 1. Demographic Data and Results on Clinical and Neuropsychological Tests.

	Participant Group						
	HCs (n = 20)		SCD (n = 20)		MCI (n = 20)		
Characteristic	M	SD	M	SD	M	SD	*P*
Age, years	70.8	7.1	66.4	6.0	71.05	6.1[a]	.042
Education, years	14.9	2.95	16.15	2.25	13.45	3.3[a]	.016
Gender, male/female	6/14	–	4/16	–	9/11	–	.23
CCSQ	1.2	1.3	3.8	2.0[b]	5.1	2.2[c]	< .001
GDS	2.75	2.3	7.5	5.5	8.2	5.1[c]	.003
ADCS-ADL	43.2	2.5	40.8	3.5	39.2	3.5[c]	.012
MoCA	26.2	2.09	26.7	2.6	24.4	2.2	.058
RL/RI							
RL1	9.05	1.7	8.7	2.45	5.3	2.3[a,c]	< .001
RL2	11.05	1.6	11.1	1.8	6.6	2.8[a,c]	< .001
RL3	11.75	2.0	11.9	1.8	7.3	3.0[a,c]	< .001
TMT							
TMT1	24.6	5.9	23.05	6.4	26.95	9.9	.109
TMT2	47.75	15.75	42.6	15.6	62.4	35.4	.262
TMT3	45.85	11.0	38.3	10.9	56.4	27.8	.119
TMT4	108.4	43.1	93.6	30.8	145.95	63.15[a]	.048
CDT	8.9	1.45	9.5	.9	7.9	1.9[a]	.031
DSST	61.65	14.8	61.1	12.2	50.4	11.6	.061
BNT	13.65	1.1	13.7	.9	12.2	1.9	.127
Verbal fluency							
T	14.6	5.15	14.1	3.0	10.1	3.7[a,c]	.001
N	9.55	3.4	9.35	2.85	7.05	4.2[a,c]	.053
P	14.25	3.5	16.45	4.85	11.85	5.1[a,c]	.009
Animals fluency	18.35	4.8	19.55	4.6	15.15	4.0[a,c]	.009

Abbreviations: ADCS-ADL, French adaptation of the Alzheimer's Disease Cooperative Study-Activities of Daily Living; BNT, Boston Naming Test, 15 items; CCSQ, Cognitive Complaints Screening Questionnaire; CDT, Clock Drawing Test; DSST, Digit Symbol Substitution Test; GDS, Geriatric Depression Scale; HCs, healthy controls; M, mean; MCI, mild cognitive impairment; MoCA, Montreal Cognitive Assessment; RL/RI, 16-item free and cued recall (RL1, 2, 3 = free recall 1, 2, 3); SCD, subjective cognitive decline; SD, standard deviation; TMT, Trail Making Test (TMT1, visual search; TMT2, number sequencing; TMT3, letter sequencing; TMT4, number–letter alternate sequencing).
[a]Symbols for significant post hoc group differences: SCD versus MCI.
[b]Symbols for significant post hoc group differences: HCs versus SCD.
[c]Symbols for significant post hoc group differences: HCs versus MCI.

equivalent to the 30 pictures corresponding to man-made concepts (tools = 6; kitchen utensils = 5; musical instruments = 4; clothes = 8; vehicles = 7) with respect to concept familiarity: t (58) =−.4, P = .69[56]; word familiarity: t (58) = −1.55, P = .13[57]; word frequency: t (58) = .89, P = .38[58]; age of acquisition: t (58) =−.52, P = .61[59]; word length in syllables: t (58) = −1.3, P = .2; and visual complexity: t (58) = .59, P = .56. Participants had to name the noun corresponding to the depicted object presented on a laptop.

The action video naming task comprised sixty 5-second videos depicting humans performing actions in a simplified environment (eg, for the verb "to cut," a person sat on a table, in front of a plain white wall, with a knife and an apple on a plate, and cut the apple). These videos were selected from the original work of Routhier et al.[60] Participants had to name the verb corresponding to the depicted action in the video presented on a laptop. All the verbs were transitive and had a predicate–argument structure allowing for 2 arguments.

Nouns (mean = 35.6, SD = 70.5) and verbs (mean = 28.2, SD = 42.9) were equivalent, t (118) = −0.07, P = .48, in terms of lexical frequency[60] and syllable length (nouns: mean = 2.01, SD = 0.75/verbs: mean = 2.03, SD = 0.18), t (118) = −0.17, P = .87.

In both naming tasks, participants' responses were rated as "correct" or "incorrect." As acceptable variants could be given in both tasks, interrater reliability was used to determine the correct responses. The examiner determined whether the answers given were correct or incorrect and wrote down the exact answers given by the participants. In action naming, answers in any verb tense were considered correct. An external judge also scored all the transcripts. Rating agreement ranged from 91% to 100%. In case of disagreement, both examiners watched the object picture or video together and rescored the answer to achieve consensus.

Verbal Fluency Tasks

Participants were administered a free object (noun) fluency task and a free action (verb) fluency task, each with a 60-second time limit. In the object fluency task, participants were

given (in French) the following instructions: "I'd like you to tell me as many different words corresponding to objects as you can think of. You must produce single words such as dog or house, rather than a sentence. However, you cannot produce proper nouns like Peter or Quebec. Can you give me an example of an object noun?" If the response was unacceptable, participants were asked to provide another example of an object noun. If the response was acceptable, the examiner said, "Good. Now, to avoid distraction, please close your eyes and tell me, in 1 minute, as many different objects as you can think of."

In the action fluency task, participants were given (in French) the following instructions, adapted from Woods et al[61]: "I'd like you to tell me as many different things as you can think of that people do. You must produce single words such as eat or drink, rather than a sentence. However, you cannot produce the same verb with different endings, like eat, ate, and eaten. Can you give me an example of something that people do?" If the response was unacceptable, participants were asked to provide another example of an action word (any verb response was acceptable). If the response was acceptable, the examiner said, "Good. Now, to avoid distraction, please close your eyes and tell me, in 1 minute, as many different things as you can think of that people do."

In each fluency task, the following variables were computed: (1) number of new words produced in 1 minute; (2) number of repeated words; (3) number of errors (ie, words not respecting the fluency criteria; (4) average semantic cluster size; (5) number of switches between semantic clusters; and (6) number of words produced in each time interval: I1: 1 to 20 seconds, I2: 21 to 40 seconds, and I3: 41 to 60 seconds. In accordance with Troyer et al,[62] a semantic cluster of object names is defined as groups of successively generated words belonging to the same semantic subcategory (eg, farm animals, pets, African animals, etc). For verbs, semantic subcategories of actions were defined according to action type (eg, speak, scream, whisper, etc; walk, run, swim) or to semantic script (eg, gardening: dig, plant, sow, etc; cooking: cook, fry, roast, etc). Switches were calculated as the number of transitions between clusters, including single words.[62]

Statistical Analyses

Data analyses were performed with SPSS (version 22). For the 2 naming tasks, the dependent measures (ie, total number of correct responses, total number of semantic errors, and total number of no responses) were analyzed using a group model analysis of variance (ANOVA). For the 2 fluency tasks, the dependent measures (ie, total responses, total repeated words, total errors, average semantic cluster size, number of switches, and number of words in each time interval) were analyzed using a group model ANOVA. Pairwise comparisons were made using Bonferroni post hoc analysis. Because MANOVA analyses indicated a significant effect of age and level of education, all analyses were also run with these variables as covariates. No changes in results were observed, so the analyses without the covariates are reported.

Correlations were performed between the experimental tasks and neuropsychological tests of language (Boston Naming Test, 15 items), executive functions (number–letter alternate sequencing subtest of the Trail Making Test [TMT] 4), and attentional control (composite score made up of the scores on the TMT1 [visual search], TMT2 [number sequencing], TMT3 [letter sequencing] of the TMT and the Digit Symbol Substitution Test of the WAIS-III battery). A significance level of $P < .01$ was used for Pearson correlations.

Table 2. Performances on Naming Tasks by Group.

	Object Naming		
	HCs	SCD	MCI
Object naming (60)	58.6 (0.11)	58.95 (0.08)	56.5 (0.22)[a,b]
Natural concepts (30)	28.85 (0.13)	29.21 (0.09)	27.3 (0.26)[a,b]
Man-made concepts (30)	29.75 (0.05)	29.74 (0.04)	29.2 (0.12)[a,b]
Action naming (60)	56.95 (0.21)	54.85 (0.27)	53.35 (0.3)[a]

Abbreviations: HCs, healthy controls; MCI, mild cognitive impairment; SCD, subjective cognitive decline.
[a]Symbols for significant post hoc group differences: HCs vs MCI.
[b]Symbols for significant post hoc group differences: SCD vs MCI.

Results

Naming Tasks

The participants' mean scores on object and action naming tasks are presented in Table 2. A repeated-measures ANOVA with stimulus category (object and action) as a within-subject factor and group (HCs, SCD, and MCI) as a between-subject factor was performed. It should be noted that one of the 20 participants with SCD did not perform the object naming task. The results showed significant effects for stimulus category ($F_{1,56} = 67.84$, $P < .001$, $\eta^2 = 0.5$) as well as a significant stimulus × group interaction ($F_{2,56} = 3.91$, $P < .05$, $\eta^2 = 0.12$). Post hoc analyses for significant results were then performed using Bonferroni correction. Simple contrasts first revealed that the performance of participants in all 3 groups was poorer in the action naming task than the object naming task (HCs: $P = .01$; SCD and MCI: $P < .001$). The analyses also revealed that, for object naming, participants with SCD performed similarly to HCs and these 2 groups differed significantly from the MCI group (HCs vs MCI: $P = .003$; SCD vs MCI: $P = .001$). For action naming, however, analyses revealed that (1) participants with SCD performed similarly to HCs ($P = .098$) and participants with MCI ($P = .32$) and (2) HCs differed significantly from participants with MCI ($P = .001$). Visual inspection of the data, P value differences between groups, and the large effect sizes (HCs vs SCD: $r = 0.97$; HCs vs MCI: $r = 0.99$; SCD vs MCI: $r = 0.94$) suggest that participants with SCD were at the midpoint between HCs and participants with MCI (ie, HCs-SCD-MCI). Note: Following Cohen,[63] effects

Table 3. Performances on Fluency Tasks by Group and Time Interval.[a]

	Object (Noun) Fluency			Action (Verb) Fluency		
	HCs	SCD	MCI	HCs	SCD	MCI
Total responses	27.80 (7.42)	25.90 (4.02)	22.65 (6.37)[b]	19.80 (6.93)	15.45 (3.32)[c]	14.35 (4.89)[b]
Interval 1 (1-20 seconds)	12.00 (2.96)	10.45 (2.09)	9.50 (2.50)	9.05 (3.44)	7.80 (1.91)	6.90 (2.31)
Interval 2 (21-40 seconds)	8.70 (3.56)	7.35 (2.35)	6.90 (2.73)	5.85 (2.60)	4.00 (1.75)	3.90 (1.74)
Interval 3 (41-60 seconds)	7.10 (3.02)	8.10 (2.49)	6.25 3.32)	4.90 (2.47)	3.65 (2.16)	3.55 (1.88)
Total repetitions	0.85 (1.14)	0.85 (.81)	0.55 (.83)	0.85 (1.14)	0.75 (0.91)	0.55 (0.76)
Total errors	1.50 (2.40)	0.90 (1.29)	0.95 (1.47)	0.75 (1.02)	0.55 (0.76)	0.55 (0.76)
Mean cluster size	1.10 (.69)	0.95 (.55)	1.89 (1.00)[b,d]	0.56 (0.33)	0.47 (0.36)	0.66 (0.36)
Total switches	14.75 (4.68)	14.70 (3.71)	8.95 (3.75)[b,d]	13.25 (4.40)	11.20 (3.75)	9.50 (3.46)[b]

Abbreviations: HCs, healthy controls; MCI, mild cognitive impairment; SCD, subjective cognitive decline; SD, standard deviation.
[a]Mean scores are raw scores, SDs are in parentheses.
[b]Symbols for significant post hoc group differences: HCs versus MCI.
[c]Symbols for significant post hoc group differences: HCs versus SCD.
[d]Symbols for significant post hoc group differences: SCD versus MCI.

sizes of 0.20, 0.50, and 0.80 were considered small, medium, and large, respectively.

For object naming, a repeated-measures ANOVA with concept category (natural and man-made) as a within-subject factor and group (HCs, SCD, and MCI) as a between-subject factor was also performed. The results showed a significant effect for concept category ($F_{1,56} = 25.2$, $P < .001$, $\eta^2 = 0.31$) and marginal effect for the concept category × group interaction ($F_{2,56} = 3.15$, $P = .051$, $\eta^2 = 0.10$). Post hoc analyses with Bonferroni correction showed that naming performance was better for man-made than natural concepts in HCs ($P = 0.023$) and participants with MCI ($P < 0.001$), but not in participants with SCD ($P = 0.15$) due to a ceiling effect. With respect to the concept category × group interaction, post hoc analyses showed the same pattern of performance (HCs = SCD > MCI) for natural and man-made concepts.

Verbal Fluency Tasks

Total responses, repetitions, and errors. Mean scores and SDs on the 2 fluency tasks by group and time interval are shown in Table 3. A repeated-measures ANOVA with fluency category (object and action) and interval (I1, I2, and I3) as within-subject factors and group (HCs, SCD, and MCI) as a between-subject factor was performed. Results showed a main effect for group ($F_{2,57} = 6.27$, $P < .003$, $\eta^2 = 0.18$). Post hoc analyses with Bonferroni correction showed that (1) participants with SCD performed similarly to HCs ($P = .13$) and participants with MCI ($P = .46$) and (2) HCs differed significantly from participants with MCI ($P = .003$). Visual inspection of the data, P value differences between groups, and effect size magnitude (small to medium for HCs vs SCD and HCs vs MCI: $r = 0.32$ and $r = 0.44$, respectively; small for SCD vs MCI: $r = 0.25$) suggest that participants with SCD were at the midpoint between HCs and participants with MCI (ie, HCs-SCD-MCI).

The results also showed a main effect for fluency category ($F_{1,57} = 121.22$, $P = .000$, $\eta^2 = 0.68$), meaning that the total new words produced was significantly higher for objects than for actions in all 3 groups. A main effect for interval ($F_{2,57} = 91.55$, $P = .000$, $\eta^2 = 0.62$) revealed that participants in the 3 groups produced more words in interval 1 compared to interval 2 ($P = .000$) and more words in interval 1 compared to interval 3 ($P = .000$), while there was no difference between intervals 2 and 3 ($P = .18$). There was no group × interval ($F = 1.5$) interaction. There was also no significant group by fluency category interaction ($F = 0.91$), but visual analysis of the data suggested the 3 groups differed for objects and action verbal fluency. Analysis of variances was therefore carried out separately for each fluency task.

The ANOVA conducted using total words produced for object fluency revealed a main effect for group ($F_{2,57} = 3.64$, $P = .033$, $\eta^2 = 0.11$). Post hoc tests showed a pattern of performance (HCs-SCD-MCI) in which only HCs and participants with MCI differed (HCs vs SCD: $P = .99$, small effect size $r = .16$; HCs vs MCI: $P = .03$, small to medium effect size $r = 0.35$; SCD vs MCI: $P = .29$, small effect size $r = 0.29$). A main effect for group ($F_{2,57} = 6.64$, $P = 0.004$, $\eta^2 = 0.17$) was also observed in the ANOVA performed with the total words produced for action fluency. Post hoc tests revealed that the performance of HCs differed significantly from participants with SCD ($P = .034$) and MCI ($P = .005$) and that the latter 2 groups did not differ from each other ($P = 1$). For action fluency, a HCs > SCD = MCI pattern of performance was therefore observed.

Finally, with respect to the number of repetitions and number of errors, there was no significant main effect for group (repetitions: $F = 1.99$; errors: $F = 1.06$) or group by fluency category interaction (repetitions: $F = 0.07$; errors: $F = 0.27$).

Cluster size. An ANOVA with fluency category (object and action) as a within-subject factor and group (HCs, SCD, and MCI) as a between-subject factor was performed. Results showed a main effect for group ($F_{2,57} = 5.21$, $P = .008$, $\eta^2 = 0.15$). Post hoc analyses with Bonferroni correction revealed that cluster size was similar in SCD and HCs, while

Table 4. Correlations Between Experimental Tasks, Neuropsychological Tests, and Depression.

	Picture Naming			Verbal Fluency		
	Object Naming	Action Naming	Total Naming	Object Fluency	Action Fluency	Total Fluency
HCs						
EF	$r = -0.15$	$r = -0.15$	$r = -0.18$	$r = -0.22$	$r = -0.18$	$r = -0.25$
AC	$r = -0.26$	$r = 0.05$	$r = -0.12$	$r = -0.18$	$r = -0.06$	$r = -0.15$
GDS	$r = 0.05$	$r = -0.43$	$r = -0.22$	$r = 0.37$	$r = 0.35$	$r = 0.45$[a]
SCD						
EF	$r = 0.21$	$r = -0.24$	$r = -0.09$	$r = 0.11$	$r = 0.01$	$r = -0.07$
AC	$r = 0.07$	$r = -0.33$	$r = -0.20$	$r = -0.01$	$r = -0.22$	$r = -0.13$
GDS	$r = 0.08$	$r = -0.12$	$r = -0.05$	$r = -0.19$	$r = -0.07$	$r = -0.16$
MCI						
EF	$r = -0.25$	$r = -0.16$	$r = -0.24$	$r = -0.38$	$r = 0.07$	$r = -0.21$
AC	$r = -0.06$	$r = -0.23$	$r = -0.20$	$r = -0.38$	$r = 0.00$	$r = -0.23$
GDS	$r = 0.06$	$r = 0.13$	$r = 0.13$	$r = -0.01$	$r = 0.29$	$r = 0.13$

Abbreviations: AC, attentional control; EF, executive functions; GDS, Geriatric Depression Scale; HCs, healthy controls; MCI, mild cognitive impairment; SCD, subjective cognitive decline.
[a] $P < .05$.

these 2 groups differed significantly from the MCI group (HCs vs MCI: $P = .03$; SCD vs MCI: $P = .016$), whose mean cluster size was larger. There was no fluency category effect ($F_{1,57} = 3.4$, $P = .069$, $\eta^2 = 0.06$), but a fluency category by group interaction was found ($F_{2,57} = 3.26$, $P = .046$, $\eta^2 = 0.10$). Post hoc tests showed no difference for cluster size between the 3 groups in action fluency. For object fluency, post hoc tests revealed that cluster size was similar in participants with SCD and HCs, whereas these 2 groups differed significantly from the MCI group (HCs vs MCI: $P = .006$; SCD vs MCI: $P = .001$).

Switching. An ANOVA with fluency category (object and action) as a within-subject factor and group (HCs, SCD, and MCI) as a between-subject factor was performed. Results showed a main effect for group ($F_{2,57} = 10.55$, $P = .000$, $\eta^2 = 0.27$). Post hoc analyses with Bonferroni correction revealed that the number of switches was similar in SCD and HCs, whereas these 2 groups differed significantly from the MCI group (HCs vs MCI: $P = .000$; SCD vs MCI: $P = .005$), in which the number of switches was smaller. There was also a fluency category by group interaction. Post hoc analyses revealed that, for object fluency, the number of switches was similar in SCD and HCs, while these 2 groups differed significantly from the MCI group (HCs vs MCI: $P = .000$; SCD vs MCI: $P = .000$). For the number of switches in action fluency, post hoc analyses showed that (1) participants with SCD performed similarly to HCs ($P = .30$) and participants with MCI ($P = .52$) and (2) HCs differed significantly from participants with MCI ($P = .01$). Visual inspection of the data, P value differences between groups, and effect size magnitude (small for HCs vs SCD and SCD vs MCI: $r = 0.24$ and $r = 0.23$ respectively; medium for HCs vs MCI: $r = 0.43$) suggest that participants with SCD were at the midpoint between HCs and participants with MCI (ie, HCs-SCD-MCI).

Correlations With Results From Neuropsychological Tests and With Depression

The relationships between naming and fluency tasks, on the one hand, and executive functions, attentional control, and depression, on the other, were examined using correlation analyses. For executive functions, correlations were calculated with the scores obtained on the number–letter alternate sequencing subtest of the TMT4. Concerning attentional control, correlations were calculated with a composite score made up of scores on the TMT1 (visual search), TMT2 (number sequencing), TMT3 (letter sequencing) of the TMT, and the Digit Symbol Substitution Test of the WAIS battery. Finally, for depression, correlations were calculated with scores obtained on the GDS (see Table 4).

As shown in Table 4, except for the total fluency score for which there was a positive and significant correlation with the GDS score in HCs, no other correlations were established for the participants in any of the groups.

Discussion

The main objective of this study was to determine the potential contribution of word production tasks to the detection of actual cognitive impairment in SCD and, more specifically, of verb compared to noun production. For naming tasks, we found that participants with SCD performed similarly to HCs in object naming, while these 2 groups differed significantly from the MCI group. In action naming, results showed a HCs-SCD-MCI pattern of performance, in which only HCs differed significantly from participants with MCI, and participants with SCD were at the midpoint between HCs and participants with MCI. For verbal fluency tasks, participants with SCD performed similarly to HCs, while these 2 groups differed from the MCI group in object fluency. For action fluency, results showed a HCs > SCD = MCI pattern of performance. When cluster size

was analyzed, there was no difference between the 3 groups in action fluency, while a HCs = SCD > MCI pattern was observed in object fluency. Finally, a similar HCs = SCD > MCI pattern was found for the number of switches in object fluency, while in action fluency, results showed a HCs-SCD-MCI pattern of performance in which participants with SCD were at the midpoint between HCs and participants with MCI. In sum, the tasks used in our study allowed, in some cases, to differentiate HCs from SCD and, in other cases, to differentiate SCD from MCI. Finally, in some other tasks, visual inspection of the results, along with *P* value differences between groups and effect sizes, showed that participants with SCD were at the midpoint between HCs and participants with MCI, therefore suggesting a possible HCs-SCD-MCI continuum of performance.

A secondary objective was to identify cognitive and psychological correlates (ie, executive functions, attentional control, and depression) of performance on naming and verbal fluency tasks in SCD. Results showed that none of the differences observed in naming and fluency tasks between SCD, MCI, and HCs could be attributed to impairment of executive functions or attentional control or to depression.

This study adds to growing evidence that SCD is actually a pre-MCI condition, representing the earliest entry point along the continuum from healthy aging to AD. At this preclinical phase, neurodegenerative changes do not entail overt impairment on formal neuropsychological tests. However, as shown in a few studies, SCD may be associated with mild difficulties on cognitive tasks exploring different types of memory: episodic memory,[61] visual short-term memory,[10] prospective memory,[11] and associative memory[12] A few other studies have shown that individuals with SCD could also have language difficulties in formal tests assessing lexical access in word production, such as picture naming[17] and semantic[14,15,20] or semantic and orthographic[17] fluency. Unlike these authors, we found impairment, not in similar formal tasks, but only in action video naming and action fluency tasks. This could be because these studies had much larger samples (number of participants with SCD: Amieva et al, n = 1050; Benito-León et al, n = 1073; Lopez-Higes et al, n = 66; Nikolai et al, n = 61) than in the present study or because we used experimental tasks of verbal fluency (ie, free object and free action fluency). The potential of action fluency to discriminate MCI from SCD and AD was suggested by Östberg et al.[19] In the present study, we provide additional support for this contention by showing that, compared to HCs, lexical access to verbs, but not to nouns, is affected in SCD in both naming and fluency tasks.

Several explanations have been proposed to account for the differential processing of nouns and verbs. According to some psycholinguistic models,[19] nouns and verbs differ in terms of processing demands: Compared to nouns, verbs require more cognitive resources at the semantic (verbs refer to events and actions featuring one or more participants), the morphological (verbs are usually produced in an inflected form requiring the application of grammatical rules), and the syntactic levels (verbs are the core unit of the sentence and their main syntactic function is to assign thematic roles [ie, agent, theme] to other words), even when they are produced in isolation. Specifically, in fluency tasks, verbs differ from nouns with respect to semantic organization. Nouns are hierarchically organized within a taxonomic structure in which units are connected through superordinate (eg, animals: mammals) and subordinate (eg, cow) links. Therefore, this strong overlap among nouns facilitates access to nouns pertaining to the same category or subcategory in fluency tasks. By contrast, verbs are not hierarchically or taxonomically organized so that retrieving a particular verb in an action fluency task primes few or no other verbs. From a cognitive viewpoint, it has been suggested that the massive amount of information required in verb processing, as well as the absence of a clear semantic organization of verbs in semantic memory, is more demanding in terms of executive resources.[64] In the present study, we did not show any correlations between action naming task or action fluency task and executive functioning, suggesting that SCD and HCs did not differ on these tasks due to a decrement in cognitive resources. The absence of correlations between orthographic and semantic fluency tasks, on the one hand, and executive functions, on the other, was also reported in some studies conducted with older people. For example, Stolwyk et al[65] showed that, compared to younger participants, older participants obtained significantly lower scores on semantic fluency tasks, but no cognitive variables (verbal intelligence, processing speed, working memory, and inhibitory control) contributed to their performance. Considering this absence of a correlation, the difference observed between HCs and SCD in verb production should be attributed to other underlying causes, such as the neural systems involved in their representation and processing.

The impairment of verb production, compared to noun production, has been demonstrated in numerous studies conducted with individuals with various neurological disorders. In neurodegenerative diseases, this impairment was reported in the nonfluent variant of primary progressive aphasia,[65] the behavioral variant of frontotemporal dementia,[21] corticobasal syndrome,[22] progressive supranuclear palsy,[22] and Parkinson disease.[22] All these conditions are characterized by a predominance of frontal lobe dysfunction suggesting, as proposed by Vigliocco et al,[66] that verb processing relies mainly on frontal brain circuitry, while noun processing is sustained by temporal and more posterior brain structures and circuits. However, this assumption is challenged by studies showing that object picture naming is better preserved than action picture naming in participants with AD who, in the early stages of the disease, show a predominance of temporal atrophy and relative sparing of frontal areas.[66] In a single-photon emission computed tomography study conducted with individuals with SCD, MCI, and AD, Östberg et al[67] showed that verb fluency impairment is predicted by a temporal lobe hypoperfusion factor. According to these authors, this impairment might reflect pathology of the anterior parahippocampal region, including the perirhinal and entorhinal cortices that are affected early in prodromal[68] and dementia stages of

AD.[69] These brain regions are known to have a determining role in retrieving cortically distributed information, such as in picture naming and fluency tasks[70] Assuming that SCD represents the preclinical stage of AD, characterized by the very first signs of cognitive impairment, our results are congruent with this neuroanatomical explanation.

The first limitation of the present study is the small sample size. A larger sample size would be needed to confirm our results and determine whether the reported pattern of performance accurately represents the populations with SCD and MCI. The cross-sectional nature of our research design is another limitation. A longitudinal study should be conducted with a larger sample to track the progression of lexical access impairment in SCD and to determine the predictive value of action naming and action fluency tasks, as was recently demonstrated for semantic verbal fluency (animals) in a study conducted with a large group of individuals with SCD.[71]

In conclusion, the present study provides evidence for the specific impairment of verb production in participants with SCD. This study confirms that older people with SCD are the best judges of their own capacities and that subjective judgments should find more resonance in the clinic and be taken more seriously for early prevention. It also provides support for the contention that SCD is a pre-MCI condition, representing the earliest entry point along the continuum from healthy aging to AD. From a clinical viewpoint, action naming and action fluency are easy to incorporate in neuropsychological test batteries and show promise in the detection of cognitive deficits at the preclinical stage of AD. The screening tests used for the diagnosis of MCI and AD (eg, MoCA, MMSE) are ineffective for individuals with SCD who show subtle cognitive difficulties. Further studies should be conducted to identify the cognitive domains and abilities affected in SCD in order to develop cognitive measures specifically adapted to this condition and useful for both primary care and specialized clinicians.

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