

The Swinging Self: The Costs of Shifting Between Self-Images in Alzheimer's Disease

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Abstract

Background: We investigated the ability of patients with Alzheimer's disease (AD) to shift between different self-images.

Methods: We developed an original task (shifting-self task) in which we invited 28 patients with AD and 30 control participants to generate "who am I" statements that describe 2 alternative self-images (ie, physical-self vs psychological-self). In a control task, participants had to generate 2 blocks of "who am I" statements (ie, physical-self block and psychological-self block).

Results: Analyses showed longer completion time in both the shifting-self and control task in patients with AD than in control participants. Completion time on the shifting-self task was longer than that on the control task in patients with AD, suggesting a shifting cost in AD. **Conclusion:** We propose that one feature of the diminished sense of self in AD is the difficulty of patients to shift between different alternating self-images.

Keywords

Alzheimer's disease, executive function, self, self-images, shifting

Introduction

Generally speaking, the self can be defined as a set of mental processes that provide us with feelings of individuality, coherence, and unity that define our uniqueness.^{1,2} There is a substantial body of research documenting a diminished sense of self in Alzheimer's disease (AD).³ For example, Addis and Tippett⁴ assessed the sense of self by asking patients with mild AD to provide responses to the question "Who am I?" and to rate personal-self statements (eg, "I'm a cheerful person"), family-self statements (eg, "I am a member of a happy family"), social-self statements (eg, "I'm a friendly person"), moral-self statements (eg, "I am a decent person"), and physical-self statements (eg, "I have a healthy body"). The authors found a weakened sense of self in AD. Similar findings were observed in a study reporting fewer production of statements describing the self (ie, statements to the question "Who am I?") in patients with mild AD than in control participants.⁵ A diminished sense of self in AD has been also reported by studies on self-defining memories, which are vivid and emotionally intense memories that help maintain self-consistency and self-coherence.⁶⁻⁹ A study assessed self-defining memories by asking patients with mild AD and healthy older adults to retrieve memories that help explain who they are.¹⁰ The study reported less specific self-defining memories in patients with

AD than in control participants. Another study demonstrated less production of self-defining memories in patients with mild AD than in healthy older adults.¹¹ One study has also found that self-defining memories were less frequently integrated and the meaning extracted from memories was less frequently tied to the self in patients with AD than in control participants.¹²

A diminished sense of self in AD has also been reported in studies demonstrating that patients with advanced AD are less likely to recognize themselves in the mirror compared to patients with mild AD.¹³⁻¹⁵ In a similar vein, Caddell and Clare¹⁶ suggested that patients with AD do often show

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difficulties with self-recognition, especially in advanced stages of the disease. A compromised sense of self has also been reported in research showing the difficulty patients with AD face in updating their self-knowledge. For instance, Klein et al (2003)¹⁷ investigated the discrepancy between a patient's ratings of current personality and the relative's ratings of that person's personality now and before the onset of dementia. The authors found that the patient's ratings were accurate but reflected self-knowledge before the onset of disease. Therefore, self-knowledge in AD may be intact, due to unimpaired semantic knowledge.¹⁸⁻²⁰ A diminished sense of self was also reported by Ruby et al²¹ who asked patients with mild AD and relatives to rate themselves and each other on a list of 40 adjectives and found decreased self-judgment accuracy in patients with AD.

Although this literature demonstrates a diminished sense of self in AD, not all aspects of the self are impaired in the disease. For instance, Baird²² reported a case of a patient who, despite severe AD, was able to demonstrate preservation of some aspects of the self. Also, a study has demonstrated that patients with mild AD can draw on personal memories to maintain a continuous sense of self or even to reflect on situations in which they are concerned about their self-continuity.²³ In a similar vein, Strikwerda-Brown et al²⁴ emphasized that, although memory loss may lead to a diminished sense of self, not all aspects of the self are impaired in AD. Also, and despite the diminished sense of self, patients with AD can draw of some aspect of the self to improve memory function. This issue was investigated by research on the self-reference effect, that is, the observation that memory performance is generally higher for information that is encoded in reference to the self than for information that is encoded semantically or in reference to other people. Research on the self-reference effect has demonstrated that self-reference may improve memory for emotional information in patients with AD.^{25,26} Also, patients with mild AD can draw on their personal and meaningful events to maintain a continuous sense of self or even to reflect on situations in which they are concerned about their self-continuity.²⁷ Together, although a diminished sense of self can be observed in AD, some aspects of the self can be preserved depending on the stage of the disease and/or individual differences.

The diminished sense of self in AD can be illustrated with the Autobiographical Memory in Alzheimer's Disease (AMAD) model.³ This model attributes the diminished sense of self to the compromise of autobiographical memory, which is memory for personal experiences.^{28,29} The AMAD model suggests that the compromise of the ability to retrieve specific autobiographical memories in AD leads to the decontextualization of memories and a shift from reliving past events to a general sense of familiarity, as observed by research demonstrating a decline in the quality of the recollective experience for autobiographical memories.³⁰⁻³² More specifically, the AMAD model suggests that autobiographical memory decline in AD limits access to memories that shape self-consciousness, self-knowledge, and self-images, leading to a diminished sense of self and identity. Interestingly, and inspired by the work of

Conway,²⁹ the AMAD model proposes the existence of a "working-self" system. This system refers to an executive system that regulates access to self-images and self-knowledge. According to the AMAD model, the compromise of working-self in AD, which is related to the compromise of executive function in the disease,³³ leads to a compromised ability to build a coherent and integrated sense of self in the disease.

According to the AMAD model, the diminished sense of self in AD can be associated with a dysfunction of the executive system that constrains and coordinates the generation of self-images and self-knowledge. The present study contributes to this executive account by assessing how the compromise of shifting may lead to a difficulty in generating self-images. More specifically, we assessed the cost (ie, an increase in reaction time) associated with shifting between several self-images by asking patients with AD to alternate between the generation of 2 self-images. To this aim, we designed a simple and original shifting task to evaluate the costs associated with shifting between 2 different self-images in AD. In this shifting task, we invited patients with mild AD and control participants to generate "who am I" statements that describe 2 alternative self-images (ie, physical-self vs psychological-self). We hypothesize that patients with AD will take longer completion time of this shifting-self task compared with a control task in which we invited participants to generate 2 blocks of "who am I" statements, the first block described physical-self and the second block described psychological-self. To further support the shifting account, we investigated the relationship between performance on the shifting-self task and performance on a task that has been widely used to assess general shifting ability (ie, the plus-minus task). We predicted there will be significant correlations between performance on the shifting-self task and the plus-minus task.

Method

Participants

We recruited 28 participants with a clinical diagnosis of probable mild AD (see Table 1 for demographic information) and 30 older adult controls. The patients with AD were recruited from local retirement homes, and the diagnosis (ie, probable AD) was made by an experienced neurologist or geriatrician according to the criteria developed by the National Institute on Aging and the Alzheimer's Association for probable AD.³⁴ The control participants were mostly spouses or companions of patients with AD, who were independent and living at home. These participants were matched with the patients with AD according to age, $t(56) = 0.23$, $P = .82$, sex, $\chi^2(1, N = 58) = 0.08$, $P = .77$, and educational level, $t(56) = 1.62$, $P = .11$.

The exclusion criteria for all participants were significant neurological or psychiatric illness and alcohol or drug abuse. None of our participants presented any major visual or auditory acuity difficulties that could prevent assessment. They freely consented to participate and were able to withdraw whenever

Table 1. Demographic and Cognitive Characteristics of Patients With AD and Older Adults.^a

Task		AD (n = 28)	Older Adults (n = 30)
Women/men		20/8	21/9
Age in years		72.82 (6.59)	72.97 (7.83)
Education in years		8.64 (2.57)	9.83 (3.03)
General cognitive functioning	MMSE	21.82 (1.47)	28.47 (1.28)
Episodic memory	Grober and Buschke	5.79 (2.28)	9.79 (2.35)
Working memory	Forward span	5.36 (1.28)	6.50 (1.76)
	Backward span	3.50 (1.23)	5.53 (1.41)
Shifting	Plus–Minus	11.93 (5.82)	5.83 (3.19)
Depression	HADS	7.04 (2.15)	4.47 (2.92)

Abbreviations: AD, Alzheimer's disease; HADS, Hospital Anxiety and Depression Scale; MMSE, Mini-Mental State Examination.

^aStandard deviations are given in parentheses; the maximum score on the MMSE is 30 points; performance on the Grober and Buschke task referred to free recall and the maximum score is 16 points; performance on the forward and backward spans was the number of correctly repeated digits; scores on the Plus–Minus task referred to completion time; the cutoff on the HADS was >10/21 points.

they wished. Cognitive characteristics and scores of all participants are described below as shown in Table 1.

Cognitive Characteristics

Clinical characteristics of all participants were evaluated with tests of general cognitive functioning, episodic memory, working memory, shifting, and depression. Scores are summarized in Table 1.

General Cognitive Functioning

General cognitive functioning was evaluated with the Mini-Mental State Examination³⁵ and the maximum score was 30 points. Lower general cognitive functioning was observed in patients with AD than in control participants, $t(56) = 18.42$, $P < .001$.

Episodic memory. Episodic memory was evaluated with a French version³⁶ of the episodic task of Grober and Buschke³⁷ in which participants had to retain 16 words, each describing an item belonging to a different semantic category. Immediate cued recall was succeeded by a distraction phase during which participants had to count backward from 374 in 20 seconds. This distraction phase was succeeded by 2 minutes of free recall and the score from this phase provided a measure of episodic recall (16 points maximum). Lower episodic memory was observed in patients with AD than in control participants, $t(56) = 6.95$, $P < .001$.

Working memory. Working memory was evaluated with the digit span tasks. Participants were asked to repeat a string of single digits in the same order (ie, forward spans) or in reverse order (ie, backward spans). Scores referred to the number of correctly repeated digits. Lower scores were observed in patients with AD than in control participants on the forward, $t(56) = 2.81$, $P = .007$, and backward spans, $t(56) = 5.84$, $P < .001$.

Shifting. Following the model of Miyake et al,³⁸ flexibility was evaluated with the plus–minus task. This task included 3 lists,

each containing 20 numbers. On list 1, participants had to add 1 to each number, whereas on list 2 they had to subtract 1 from each number, and on list 3, to add and subtract 1 alternately. Participants were instructed to complete the lists quickly and accurately, and list completion times were measured by a stopwatch. The score referred to the difference between the time participants needed to complete list 3 and the average time that participants needed to complete lists 1 and 2 (the higher the score, the lower the shifting). Longer completion time was observed in patients with AD than in control participants, $t(56) = 4.99$, $P < .001$.

Depression. We used the Hospital Anxiety and Depression Scale³⁹ which consists of 7 items that were scored by participants on a 4-point scale ranging from 0 (not present) to 3 (considerable). The cutoff for definite depression was set at >10/21 points.⁴⁰ Needless to say that participants with score above the cutoff were excluded. Higher scores were observed in patients with AD than in control participants, $t(56) = 3.79$, $P < .001$.

Procedures

Participants were invited to produce 10 verbal statements to the question “Who am I?”; half of the statements describe physical-self and the other half psychological-self. More specifically, following Addis and Tippett,⁴ we invited participants to provide very short statements, beginning with the phrase “I am,” that they felt were essential to defining who they are. We explained that responses should reflect stable and enduring aspects of identity, and these aspects should reflect, respectively, physical or personality traits. Following Charlesworth et al,⁴¹ we explained that physical-self statements should reflect attributes that were apparent from appearance (eg, beautiful, small, sick), and psychological statements should reflect a personality trait (eg, confident, honest) or an emotional state (eg, happy, calm, sad). Note that only 10 statements were assessed because a previous study has demonstrated limited production of “who am I” statements in mild AD.⁵

The main experimental feature of our study was the following: Participants were invited to shift between the production of statements describing physical- and psychological-self. The order or the 2 categories (physical- and psychological-self) were randomized across participants. The participants were provided with 2 examples of shifting, each example depicting in different color a statement describing physical-self (ie, "I am tall" printed in blue) and another one describing psychological-self (ie, "I am friendly" printed in red). These examples were printed on a white A4 sheet of paper. To ensure that participants understood the requirements of the task, they were asked to repeat the instructions using their own words. Further explanations were provided if necessary to ensure complete comprehension. Prior to testing, participants were instructed to complete the task quickly, and completion times (in seconds) were measured by a stopwatch. Performance referred to the completion time of the task; the higher the score, the lower the shifting. Note that our task was based on that used by Rathbone and Moulin⁴² who used a switching task in which young participants (generally undergraduates) retrieved memories cued by alternated self-image cues or the same cue repeatedly. However, in our study, participants were not invited to retrieve memories but only to alternate between physical- and psychological-self.

The procedures of the shifting-self task were replicated in a control task. The only difference was that in the control task, participants were invited to generate 2 blocks of "who am I" statements. The first block consisted of 5 statements describing physical-self and the second block consisted of 5 statements describing psychological-self. The 2 blocks were counterbalanced across the participants. We also counterbalanced the order in which participants performed the shifting-self and control tasks; the 2 tasks were separated by the cognitive examination.

Results

To test our first hypothesis (ie, our expectation that patients with AD will take longer completion time of this shifting-self task compared with a control task), we compared the performance of patients with AD and control participants on the shifting-self and controls tasks. Performance was compared with a repeated measure analysis of variance with group (patients with AD vs control participants) as the between-participants factor and condition (shifting-self vs control task) as the repeated measure. Note that variables were plotted and checked for normal distribution with Kolmogorov-Smirnov tests. To test our second hypothesis (ie, our expectation about significant correlations between performance on the shifting-self task and the plus-minus task), we analyzed the correlation between performance on the shifting-self and control tasks and the plus-minus task in each population with Pearson correlations. We also analyzed differences on the number of "who am I" statements between patients with AD and control participants on the shifting-self and control tasks. Performance was compared with nonparametric tests as the data did not follow a

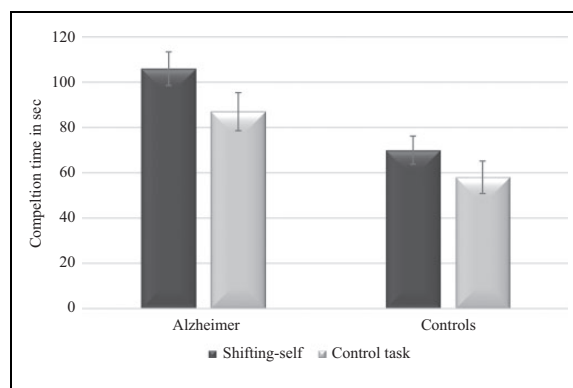


Figure 1. The completion time of the shifting-self and control tasks in patients with Alzheimer's disease and control participants. Error bars are 95% within-subject confidence intervals.

Gaussian distribution. For all tests, the level of significance was set as $P \leq .05$.

Shifting Costs in AD

Completion time is depicted in Figure 1. Analyses showed a significant group effect, $F(1, 56) = 22.31, P < .001, \eta^2 = 0.58$; longer completion time was observed in patients with AD (mean [M] = 100.54, standard deviation [SD] = 39.31) than in control participants ($M = 64.47, SD = 21.30$). The task condition effect was also significant, $F(1,56) = 33.43, P < .001, \eta^2 = 0.37$, and longer completion time was observed on the shifting-self ($M = 91.41, SD = 41.17$) than on the control task ($M = 72.31, SD = 31.23$) in all participants overall. The interaction effect between group and condition was also significant, $F(1,56) = 5.23, P = .026, \eta^2 = 0.08$. Independent samples t tests demonstrated longer completion time in patients with AD than in control participants on the self-shifting task, $M_{AD} = 114.07, SD = 44.26, M_{controls} = 70.33, SD = 23.52, t(56) = 4.74, P < .001$, and control task, $M_{AD} = 87.00, SD = 35.28, M_{controls} = 58.60, SD = 18.86, t(56) = 3.86, P < .001$. Paired t tests demonstrated longer completion time on the self-shifting task than on the control test in patients with AD, $t(27) = 6.48, P < .001$, and control participants, $t(29) = 2.26, P = .031$.

Significant Correlations Between Performances on Shifting-Self and Plus-Minus Tasks in Patients With AD

As illustrated in Figure 2, significant correlations were observed between performance on the shifting-self task and plus-minus task in patients with AD ($r = 0.56, P = .002, 95\% \text{ confidence interval [CI]: } 0.18\text{-}0.75$) and control participants ($r = 0.48, P = .007, 95\% \text{ CI: } 0.14\text{-}0.72$). No significant correlations were observed between the performance on the control task and plus-minus task. To investigate any potential effect of depression, we conducted partial correlations, controlling for depression scores; analysis demonstrated significant correlations between performance on the shifting-self

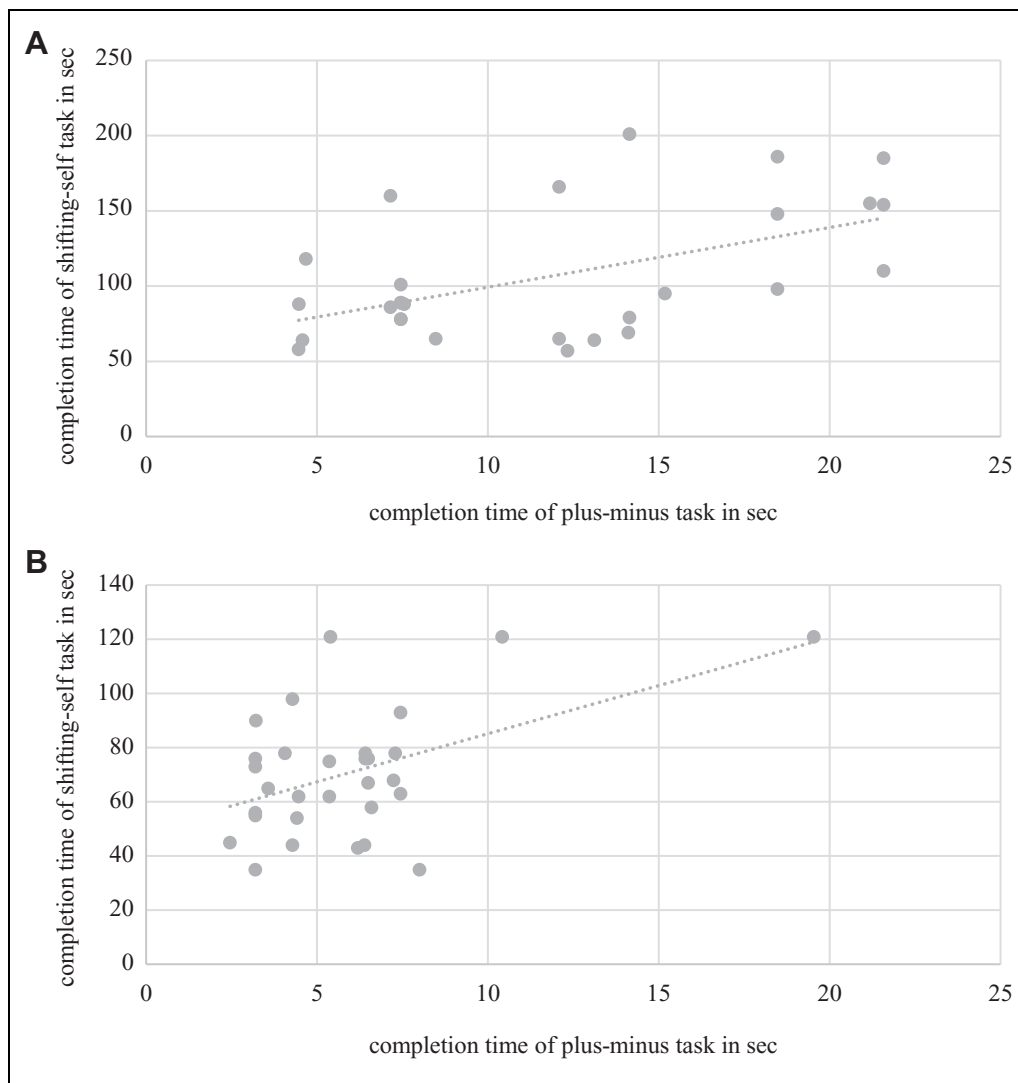


Figure 2. Correlations between performances on the shifting-self task and plus-minus task in patients with Alzheimer's disease (A) and control participants (B).

task and plus-minus task in patients with AD ($r = 0.43$, $P = .014$, 95% CI: 0.07-0.59) and control participants ($r = 0.41$, $P = .011$, 95% CI: 0.06-0.54); no significant correlations were observed between the performance on the control task and plus-minus task.

Few "Who Am I?" Statements in AD

The means of "who am I" statements are provided in Table 2. We analyzed the number of "who am I?" statements between patients with AD and control participants on the shifting-self and control tasks. Similar total number of statements was observed in patients with AD in the shifting-self ($M = 7.74$, $SD = 2.24$) and control task ($M = 7.03$, $SD = 2.97$; $Z = -0.68$, $P = .49$). Similar total number of "who am I?" statements was observed in control participants in the shifting-self ($M = 9.38$, $SD = 0.31$) and control task ($M = 8.94$, $SD = 1.04$; $Z = -0.31$, $P = .75$). Regarding the shifting-self task, fewer total number

of "who am I" statements was produced by patients with AD than by control participants ($Z = -2.46$, $P = .014$). Compared to control participants, patients with AD produced fewer statements when describing physical-self ($Z = -2.62$, $P = .009$) and psychological-self ($Z = -2.51$, $P = .012$). Patients with AD produced similar "who am I" statements when describing physical- and psychological-self ($Z = -0.29$, $P = .77$). Control participants also produced similar "who am I" statements when describing physical- and psychological-self ($Z = -0.08$, $P = .94$). Regarding the control task, fewer total number of "who am I" statements were produced by patients with AD than by control participants ($Z = -2.42$, $P = .015$). Compared to control participants, patients with AD produced fewer statements when describing physical-self ($Z = -2.00$, $P = .045$) and psychological-self ($Z = -2.48$, $P = .013$). Patients with AD produced similar "who am I" statements when describing physical-self and psychological-self ($Z = -0.18$, $P = .86$). Control participants also produced similar "who am I"

Table 2. The Means of “Who Am I” Statements Produced by Patients With AD and Older Adults in the Self-Shifting and Control Tasks When Describing Physical- and Psychological-Self.^a

	AD		Older Adults	
	Physical-Self	Psychological-Self	Physical-Self	Psychological-Self
Self-shifting	3.83 (1.16)	3.91 (1.07)	4.70 (0.31)	4.67 (0.35)
Control task	3.61 (1.38)	3.42 (0.99)	4.57 (0.42)	4.37 (0.62)
Total	7.44 (2.55)	7.33 (2.66)	9.27 (0.71)	9.04 (0.95)

Abbreviation: AD, Alzheimer's disease.

^aParticipants were required to provide 5 statements describing physical-self and 5 statements describing psychological-self; standard deviations are given in parentheses.

statements when describing physical-self and psychological-self ($Z = -0.20$, $P = .84$).

Discussion

We, for the first time, assessed the cost associated with shifting between different self-images in AD. Our results demonstrated longer completion time on the shifting-self and control tasks in patients with AD than in control participants. Completion time on the shifting-self task was longer than that on the control task in patients with AD, suggesting a shifting cost in AD. Interestingly, and unlike performance on the control task, performance on the shifting-self task was significantly correlated with performance on a typical shifting task (ie, the plus-minus task), further supporting the shifting account.

The main finding of this study was the longer completion time of the shifting-self task in patients with AD. This longer retrieval time can be interpreted in terms of a shifting cost by which generating alternate self-images leads to a lengthy and laborious cognitive processing in patients with AD. We attribute this laborious process to the necessity to alternate between the activation of different self-images. In our task, participants had to activate a self-image (eg, physical-self) and switch to another self-image (eg, psychological-self), and so on. Our assumption reflects basic functioning of shifting, as shifting typically requires the activation of a new task set and inhibition of the currently irrelevant task set.⁴³⁻⁴⁵ Another explanation of the shifting costs, as observed in our participants with AD, is the general executive resources that should be devoted to shift between different mental representations in the shifting-self task. Because executive function is compromised in AD,³³ this may explain why our participants with AD had difficulties performing the shifting-self task.

At the theoretical level, our findings can be interpreted in light of the AMAD model (which we described in Introduction). As previously mentioned, this model attributes the diminished sense of self in AD to a general dysfunction of the executive system (ie, the working-self system) that constrains and coordinates the generation of self-knowledge and self-images. By demonstrating a difficulty to shift between different self-images, our findings provide empirical support to the assumption that the sense of self is mediated by an executive center, as proposed by the AMAD model.

Regardless of the shifting costs, fewer “who am I” statements were produced by patients with AD than by control participants. This finding mirrors previous research demonstrating the diminished sense of self in AD.^{10,11,13,14,16} More specifically, this finding mirrors the compromised ability to generate “who am I” statements in AD.^{4,5} Furthermore, fewer “who am I” statements were produced by patients with AD than by control participants when describing physical- and psychological-self. These findings demonstrate a diminished ability to produce images related to specific self-dimensions in AD, which is not surprising as the disease affects the physical and psychological well-being of patients.

Regarding control participants, our findings mirror those of a previous study assessing the ability of healthy older adults to shift between self-images.⁴⁶ In this study, older and younger adults were invited to shift between physical-self statements and psychological-self statements. Results demonstrated slower completion time on the shifting-self task in older than in younger adults. The study attributed the slow shift between self-images in older adults to some self-stability (ie, rigid mental concepts) in aging. In other words, the tendency of older adults to shift between self-images more slowly than younger adults might be because they have more consistent or stable self-concepts and are therefore less inclined to “change” their self-images.

One limitation of our article may be the lack of assessment of verbal fluency as performances on the self-shifting and the control tasks require verbal production. Future research can include a verbal fluency task to assess whether performances of patients with AD on the self-shifting task are associated with decline in verbal fluency.

To summarize, this is the first study to assess shifting between different self-images in AD. This is also the first study to demonstrate costs associated with this kind of shifting. We propose that one feature of the diminished sense of self in AD is the difficulty of patients to shift between different alternating self-images.

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