Acta Neurol Scand 2001: 104: 296–300
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ACTA NEUROLOGICA
SCANDINAVICA
ISSN 0001-6314

Self-consciousness and Alzheimer's disease

R. Gil[1], E. M. Arroyo-Anllo[1], P. Ingrand[2], M. Gil[1], J. P. Neau[1], C. Ornon[1], V. Bonnaud[1]

[1]Service de Neurologie, CHU de la Milétrie, Poitiers, France; [2]Département de Biostatistiques, Faculté de Médecine et de Pharmacie, Poitiers, France

Gil R, Arroyo-Anllo EM, Ingrand P, Gil M, Neau JP, Ornon C, Bonnaud V. Self-consciousness and Alzheimer's disease. Acta Neurol Scand 2001: 104: 296–300. © Munksgaard 2001.

Objectives – To propose a neuropsychological study of the various aspects of self-consciousness (SC) in Alzheimer's disease. *Methods* – Forty-five patients with probable mild or moderate AD were included in the study. Severity of their dementia was assessed by the Mini Mental State (MMS). Fourteen questions were prepared to evaluate SC. *Results* – No significant correlations were found between SC score and educational level, age, and duration of disease. A significant correlation was found between SC score and the severity of dementia, whereas frontal disturbances were just short of the significance threshold. The various aspects of SC were not impaired to the same degree. The most disturbed ones were awareness of cognitive deficiencies, moral judgements and prospective memory. The least disturbed aspects were awareness of identity and of mental representation of the body. Items relating to anosognosia and moral judgements were significantly correlated with the MMS score, whereas affective state, body representation disorders, prospective memory, and capacities for introspection were not related to the severity of the dementia. Consciousness of identity was sound, regardless of MMS score. *Conclusions* – AD clearly induces an heterogeneous impairment of SC. SC requires a convergence of many neural networks. In AD, neuronal alterations involve many cortical areas and information sent to the associative frontal cortex from memory, language and visuospatial areas is lacking or disturbed. Thus, the sequential order of successive stimuli cannot be maintained by the heteromodal associative cortex (dorsal convexity of the prefrontal cortex), and the supramodal associative cortex (located rostrally in the frontal lobes) is unable to provide reliable monitoring and assessment of simultaneous neural cognitive networks carrying insufficient and inadequate input. The core deficiency in AD patients might be impaired SC equated with the disability to maintain sequential and simultaneous "attention to life". The Self-Consciousness Questionnaire, a clinical scale providing multidimensional measurement, indicates that different aspects of consciousness are not correlated with overall cognitive deficiency as determined by the MMSE.

Key words: self-consciousness; Alzheimer's disease; dementia

Prof. Roger Gil, Clinique Neurologique, CHU La Miletrie, 86021 Poitiers, Cedex 05, France

Accepted for publication May 25, 2001

Consciousness is first of all an "experience" that determines the state of awareness. Husserl (1) defined the state of consciousness as an "intentional" state, which means that it corresponds to aiming at "something" and supposes "a certain attention to life" (2). In this sense, consciousness is coextensive with "mind" (3). Self-awareness, or reflexive consciousness or ontogenic consciousness (4), is the understanding that the subject has of his own states of consciousness. The subject can thus separate himself from his perception and realize that he is in the process of perceiving. The reflexive consciousness allows the subject to be the object of his awareness. At the same time, because he knows that he is thinking, he is the object of his awareness. The aphorism of Descartes ("I think, therefore I am") shows that man can realize that he is thinking and also deduce from this the reality of his existence.

Self-consciousness is multifaceted (4–8). It is awareness of the body, that is of its morphological characteristics as well as its position and mobilization in space. Self-awareness is also the consciousness of perceptions. Self-awareness is the consciousness of one's own history, of one's autobiography

(3). It is thus inseparable from memory, thanks to which the identity of each human being is constructed. Self-consciousness is the consciousness of one's own projects. Finally, self-consciousness is a moral consciousness that allows the human being to make judgements about his thoughts and actions. In the extreme sense, the impairment of self-consciousness implies that the subject is no longer conscious of existing.

Throughout life, self-consciousness assembles a stream of perceptions, thoughts, recollections, projects and actions which express the permanence and coherence of the ego and thus of the human person. If consciousness can be the object of scientific study (3, 5), searching for impairment of self-consciousness in a patient requires considering which aspects of self-awareness are altered or preserved. Finally, assumptions need to be made about the mechanisms governing the alteration of self-consciousness as a function of lesion sites and models of the functioning of higher nervous activities (5, 9).

Alzheimer's disease (AD) raises the question of impairment of self-consciousness in the clearest and probably most exemplary manner. AD involves disorders of the memory as well as of other cognitive functions and leads to a progressive overall deterioration of the intellect and the personality (10–12). Studies of self-consciousness during AD concern essentially the anosognosia of cognitive disorders.

The purpose of this work was to propose a neuropsychological study of self-consciousness (SC) in a population of patients with AD in an attempt to answer the following questions: Are the different aspects of self-consciousness affected homogeneously or heterogeneously? What are the relations between alteration of SC and the natural history of the disease? What assumptions can be made about the mechanisms of alteration of SC during AD?

Table 1. The 14 questions selected in order to evaluate some aspects of self-consciousness (SC questionnaire)

1. What is your name (surname and first name)?
2. Why have you come to see me?
3. Do you have any health problems that prevent you from leading a normal life?
4. Have you got any problem with your memory?
5. Have you had a job? What was it?
6. What is the first name of your spouse (or partner)?
7. What is your mother's first name?
8. Do you feel rather happy or unhappy? Why?
9. Would you say that you are rather fair or dark-haired?
10. Are you now sitting, standing or lying down?
11. What are you planning to do shortly or tomorrow?
12. If you had to live your life over again, is there anything you would like to change? What?
13. Is it a good thing or a bad thing to tell a lie? Why?
14. Is it a good thing or a bad thing to give some money or some food to someone who is starving? Why?

Patients and methods

Fourteen questions were prepared to obtain information from the patient about certain aspects of SC (Table 1). Four of these questions concerned identity (Nos 1, 5, 6, 7), three knowledge of cognitive disturbances (metamemory or metacognition: Nos 2, 3, 4), one self-evaluation of the affective state (No. 8), two knowledge about representation of the body (Nos 9, 10), one about anticipation [memory of the future in the sense of Ingvar (1985) or prospective memory (No. 11)], one capacities for introspection (No. 12), and two moral judgements (Nos 13, 14). These were simple questions intended to study SC as ecologically as possible, i.e. in a manner as close as possible to the everyday life of subjects.

In a preliminary study, the criteria for rating replies were carefully determined by three of us (a neurologist and two neuropsychologists) as relevant (two points), incorrect (no points) or partly correct (one point). The score obtained for each of these aspects of consciousness was divided by the number of questions corresponding to each aspect. Thus, the total maximum score for the seven aspects was 14 points.

To contrast the total integrity and alteration of SC, the partly correct and incorrect answers were grouped together as poor answers with respect to "relevant" ones as good answers. The assistance of the family was always needed to check the accuracy of the answers with reference to the autobiography and the affective state.

In a first part of the study, test–retest reliability (Spearman correlation) and interobserver reliability (Kendall correlation) for the questionnaire were analysed (10) in 18 patients (9 men and 9 women) with a mild ($n=4$; Mini Mental State >20) or moderate ($n=11$; $10<$ Mini Mental State <21) form of AD according to NINCDS–ADRDA criteria (13) and DSM-IV-R (14).

The second part of the study concerned 45 patients with a mild [Mini Mental State (15) (MMS >20] or moderate ($10<$MMS<21) form of AD. The examiners ensured that the answers were understood by the patients, and only those whose verbal comprehension (assessed by the MMS' three-stage command) was equal to or above 2 were included in the study. A frontal score was determined for each patient based on the performance of a group of tests exploring frontal functions, which were assembled by Slachevsky et al. (16) under the designation "Frontal assessment short test".

The number of poor answers was calculated for each aspect of SC. Multiple pairwise comparisons were performed by a chi-square test with Bonferroni correction. Comparisons of scores of patients with

an MMS of 10 to 20 with those whose MMS was greater than 20 were done using the Student's *t*-test. The profile of the Self-Consciousness Questionnaire was analysed by determining possible correlations between each item and the MMSE.

Results

The 18 patients in the preliminary study had a mean age of 76.5 years (±9.34), a mean MMS score of 15.91 (±7), and a mean disease course of 60.56 months (±29.98). Interobserver reliability was 0.96 (Kendall correlation; $P<0.0001$) for SC (Self-Consciousness Questionnaire) score and 0.58 for MMSE score ($P=0.0008$). Test–retest reliability (evaluated at 2-week intervals) was 0.73 (Spearman correlation; $P<0.0001$) for SC score and 0.69 for MMSE score ($P=0.004$).

The questionnaire was then administered to the population of 45 patients, which had a mean age of 73.91 years (±7.70), a mean disease course of 43.66 months (±21.46), a mean MMS score of 18.82 (±5.21), and a mean frontal score of 8.77 (±3.35). Twenty-seven patients had an MMS of 10 to 20, and 18 were above 20. Thirty-four had a level (17) of primary school studies (educational level of 2 and 3) and 11 a secondary school or university level (educational level of 4 to 7).

Neither age nor educational level (Table 2) differed significantly in mild and moderate forms of the disease. The length of disease was greater in the group of patients with the lowest MMS, although the difference did not reach the threshold of statistical significance. Conversely, the frontal score was significantly more altered in the group of patients with the lowest MMS. Likewise, the total score for the SC questionnaire was significantly lower in the group of patients with the lowest MMS.

No significant correlation was found (Table 3) between the score for the SC evaluation questionnaire and educational level or age. There was a slight correlation between the SC score and the length of disease, although this correlation did not reach the threshold of statistical significance. Conversely, there was a significant correlation between the SC and the severity of the cognitive deficiency evaluated by the MMS, whereas the correlation with frontal score was very close to the significance threshold. There was a significant correlation between the MMS and frontal scores ($r=0.65$, $P<0.001$).

Table 2. Comparison of patients with mild and moderate Alzheimer's disease

	MMS 10–20	MMS >20	T (Student)	Significance
Age	75.18 (7.9)	72 (7.1)	1.37	NS
Educational level	3.14 (1.29)	3.55 (1.42)	0.99	NS
Duration of disease	47.33 (23.11)	38.16 (17.75)	1.41	NS
Frontal score	7.22 (2.87)	11.11 (2.61)	4.61	S ($P<0.0001$)
Self-consciousness score	11.39 (2.83)	12.62 (1.34)	2.68	S ($P<0.01$)

Table 3. Correlation coefficients between self-consciousness score and educational (EL), age, duration of disease (DD), MMS and "Frontal Assessment Short test" (Frontal score: FS)

EL	Age	DD	MMS	FS
0.008	−0.33	−0.25	0.46*	0.28**

* $P<0.001$.
** $P=0.055$.

However, the different aspects of SC were not disturbed with the same degree of intensity. For the 45 subjects, 68.90% of poor answers (incorrect plus partly correct answers) were obtained for anosognosia, 46.67% for moral judgements, 40% for prospective memory, and only 6.67% for representation of the body. The distribution of good and poor answers is indicated in Table 4. Pairwise comparisons of the number of poor answers with each of the aspects of SC (with Bonferroni correction) showed that awareness of the disease was more often altered than any other aspect of SC. Moreover, poor answers to moral judgements were fewer than poor answers to questions exploring anosognosia, and more numerous than poor answers to questions exploring all other aspects of SC except prospective memory. Thus, it would appear that the most disturbed aspects of SC were consciousness of cognitive disorders (metacognition), moral judgements and prospective memory, whereas the two least disturbed aspects were consciousness of identity and consciousness of representation of the body.

Consciousness of identity was explored by items 1, 5, 6 and 7. All patients replied to item 1. Among the other three items, only item 7 (mother's first name) was significantly correlated with the MMS score

Table 4. Wrong answers to the questions evaluating the various aspects of self-consciousness (45 patients). Pairwise comparisons (Chi-square test with Bonferroni's correction; significance level: 0.0025)

Aspects of self-consciousness	Wrong answers	Non-significant ($P>0.0025$) pairwise comparison with	Significant ($P<0.0025$) pairwise comparison with
F1 Identity	5 (11.10%)	F3, F4	F2, F5, F6, F7
F2 Anosognosia	31 (68.90%)		F1, F3, F4, F5, F6, F7
F3 Affective state	7 (15.56%)	F1, F6	F2, F4, F5, F7
F4 Body's representation	3 (6.67%)	F1	F2, F3, F5, F6, F7
F5 Future memory	18 (40%)	F7	F1, F2, F3, F4, F6
F6 Introspection	10 (22.22%)	F3	F1, F2, F4, F5, F7
F7 Moral judgments	21 (46.67%)	F5	F1, F2, F3, F4, F6

Table 5. Correlation analysis between MMS score and each item of the self-consciousness questionnaire. All patients replied to items 1 and 10

Items	*r*	*P*-value
2	0.502	0.0004 (S)
3	0.397	0.0064 (S)
4	0.375	0.0106 (S)
5	0.181	0.2366 (NS)
6	0.228	0.1317 (NS)
7	0.422	0.0035 (S)
8	0.021	0.8932 (NS)
9	0.113	0.4623 (NS)
11	0.129	0.3993 (NS)
12	0.036	0.8135 (NS)
13	0.350	0.0180 (S)
14	0.409	0.0049 (S)

S: significant; NS: not significant.

($r=0.42$; $P=0.003$). Each of the three items exploring anosognosia (items 2, 3 and 4) were significantly correlated with MMS (Table 5). Item 8 (affective state) was not significantly correlated with MMS. Two items (9 and 10) explored representation of the body. All patients replied to item 10 and item 9 was not significantly correlated with MMS. Items 13 and 14 (moral consciousness) were significantly correlated with the MMS score.

Discussion

AD clearly induces an alteration of self-consciousness, but not a total abolition, so that it cannot be said that patients are unaware of existing or more generally that reflexive consciousness no longer exists. Moreover, alteration of self-consciousness is heterogeneous. Anosognosia is the self-awareness alteration most commonly observed and the only aspect of SC that has already been frequently studied during AD (18). Anosognosia is related to the degree of cognitive deficiency for Migliorelli et al. (19), and Starkstein et al. (20), and to the severity of cognitive deficiency and involvement of frontal functions for Lopez et al. (21). For Ott et al. (22), the severity of anosognosia is related to the deficiency of frontal and visuospatial functions. Reed et al. (23) observed that anosognosia is associated with a deficiency in the perfusion of the dorsolateral portion of the right frontal lobe, and these authors noted in psychometric terms a relation between the existence of anosognosia and mistakes in recognition memory, whereas no relation was found with other memory tests or the severity of dementia. For Dalla Barba et al. (24), anosognosia of memory deficiency is required for subjects to experience intrusions, whereas frontal dysfunction is not a necessary condition for the onset of anosognosia. Michon et al. (25) and Nargeot et al. (26) noted a relation between the severity of anosognosia and signs of frontal dysfunction, but not with the severity of cognitive deficiency. In our population, a significant correlation was found between anosognosia score and the severity of dementia, but also with the severity of frontal disorders. In our series of patients, it proved impossible to distinguish between the role played by severity of cognitive deficiency and that of frontal dysfunction. In fact, there was a high correlation between MMS and frontal scores ($r=0.658$; $P<0.001$). Moreover, each of the three items exploring anosognosia (items 2, 3, 4) appeared to be significantly related to the overall cognitive deficit evaluated by MMS. Conversely, items exploring the consciousness of identity gave dissociated results. All patients in our series with moderate or severe forms of AD were able to give their surname and first name. Moreover, items 5 and 6 (job, spouse's or partner's first name) were not correlated with the MMS score; only item 7 (mother's first name) was linked to the MMS score, probably because it was one of the least consolidated aspects of autobiographical memory.

As the affective state appears to be independent of dementia severity, it is necessary to search for depressive manifestations in both mild and moderate dementia. All patients replied to item 10, and the score for item 9 was not correlated with the MMS score: in fact, very few patients had body representation disorders, so that this aspect appeared quite sound. Neither prospective memory (though often deficient) nor capacities for introspection seemed to be related to the MMS score. However, it is particularly noteworthy that moral judgements were significantly correlated with the MMS score. Thus the Self-Consciousness Questionnaire is a multidimensional form of measurement. The questionnaire, like the MMS, provides an overall assessment of cognitive deficiency, but it is also a clinician-assisted scale whose items are not all related to the MMS. Thus, it allows a better understanding, from one patient to another, of the heterogeneity of SC alteration in AD.

Consciousness requires the synthesis of information from countless neuronal networks located in brain areas involved in the processing of sensorial data, memory, and the management of emotional life (5). Thus, consciousness implies an assembly of information arranged sequentially, thereby allowing a choice of the actions to be undertaken. Consciousness is thus the implementation of a "supervisory" system (5) that considerable clinical evidence has related to the frontal lobe (27, 28). SC offers the capacity to control the supervisory system, thereby representing the summit of the cognition hierarchy.

In the monkey, the prefrontal multimodal associative areas receive information from all unimodal associative areas and from all other multimodal

associative areas (29). These observations have enabled models for the organization of connections in the human frontal lobe to be established (30, 31). In AD, neuronal alterations involve a large number of cortical areas of the allocortex and the isocortex as well as the connections between them (32). The information normally arrives in the associative frontal cortex. It is possible to distinguish between a multimodal associative frontal cortex and a supramodal one representing the most phylogenically recent portions located in the rostral-most part of the frontal lobe (9). The disconnection of the former (particularly of the dorsolateral frontal cortex) could account for disturbances in the sequential organization of information (9). The disconnection of the latter could account for difficulties in ensuring synthesis, i.e. the processing of information activated simultaneously. This probably constitutes the difficulty of concentrating "attention on life" (2), which could be the common denominator for SC alteration during AD. The alteration of SC could represent the central deficiency in AD. It is still necessary to evaluate the role of this impairment in disorders of the activities of everyday life, behavioural disorders and associated distress as well as the human and ethical problems raised by this disease.

Acknowledgement

We thank Stéphane Karolewicz for his kind cooperation and James Gray for his English revision.

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