Neuropsychologia 50 (2012) 2075–2084

Contents lists available at SciVerse ScienceDirect

Neuropsychologia

journal homepage: www.elsevier.com/locate/neuropsychologia

Note

Emotional reactivity and awareness of task performance in Alzheimer's disease

Daniel C. Mograbi [a,*], Richard G. Brown [a], Christian Salas [b], Robin G. Morris [a]

[a] King's College London, Institute of Psychiatry, Department of Psychology, De Crespigny Park, London, SE5 8AF, UK
[b] University of Wales, Centre for Cognitive Neuroscience, School of Psychology, Bangor/Gwynedd, LL57 2DG, UK

ARTICLE INFO

Article history:
Received 3 January 2012
Received in revised form
17 April 2012
Accepted 8 May 2012
Available online 18 May 2012

Keywords:
Dementia
Anosognosia
Awareness
Emotional reactivity
Success–failure manipulation

ABSTRACT

Lack of awareness about performance in tasks is a common feature of Alzheimer's disease. Nevertheless, clinical anecdotes have suggested that patients may show emotional or behavioural responses to the experience of failure despite reporting limited awareness, an aspect which has been little explored experimentally. The current study investigated emotional reactions to success or failure in tasks despite unawareness of performance in Alzheimer's disease. For this purpose, novel computerised tasks which expose participants to systematic success or failure were used in a group of Alzheimer's disease patients ($n=23$) and age-matched controls ($n=21$). Two experiments, the first with reaction time tasks and the second with memory tasks, were carried out, and in each experiment two parallel tasks were used, one in a success condition and one in a failure condition. Awareness of performance was measured comparing participant estimations of performance with actual performance. Emotional reactivity was assessed with a self-report questionnaire and rating of filmed facial expressions. In both experiments the results indicated that, relative to controls, Alzheimer's disease patients exhibited impaired awareness of performance, but comparable differential reactivity to failure relative to success tasks, both in terms of self-report and facial expressions. This suggests that affective valence of failure experience is processed despite unawareness of task performance, which might indicate implicit processing of information in neural pathways bypassing awareness.

1. Introduction

Reduced awareness about cognitive deficits or illness, also termed anosognosia, is a common feature of Alzheimer's disease (AD) (Morris & Hannesdottir, 2004). This phenomenon has important implications for help seeking behaviour and treatment compliance (Patel & Prince, 2001), has a role in safety (Starkstein, Jorge, Mizrahi, Adrian, & Robinson, 2007) and contributes to caregiver burden (Seltzer, Vasterling, Yoder, & Thompson, 1997). Unawareness varies according to the object (Markova & Berrios, 2001), and, in the case of AD, can range from unawareness about the diagnosis and the condition itself to reduced awareness of deficits in specific abilities. One important aspect of unawareness in AD is impaired monitoring of performance during tasks, which affects direct evaluation of ability and may have a considerable impact on how an individual adapts to deficits and on their activities of daily living.

Impaired monitoring of errors is common in AD, with evidence indicating that patients have difficulties detecting and correcting errors during everyday tasks (Bettcher, Giovannetti, Macmullen, & Libon, 2008; Giovannetti, Libon, & Hart, 2002). Ability to monitor performance in cognitive tests has also been shown to be affected in AD. For example, metamemory research (for a review, see Souchay, 2007) has indicated that patients have reduced awareness of their performance during memory tasks, with a tendency to overestimate functioning (e.g., Agnew & Morris, 1998; Clare, 2002; Correa, Graves, & Costa, 1996; Hannesdottir & Morris, 2007), although there can be normal levels of confidence judgements when recalling individual memory items (Backman & Lipinska, 1993; Pappas et al., 1992). Unawareness of impairment can also be domain-specific, affecting some abilities but not others (e.g., Banks & Weintraub, 2008; Barrett , Eslinger, Ballentine, & Heilman, 2005).

In contrast, to the findings concerning explicit self-rating of performance, there is evidence, nevertheless, that AD patients may be responding to task failure through various forms of behavioural adaptation, which may or may not be associated with full awareness. For example, the adoption of driving restrictions is often done voluntarily by patients, and is not strongly associated with awareness about loss of function (Cotrell & Wild, 1999). In addition, there is recent evidence for implicit processing of the concepts associated with task failure. Specifically, Martyr et al. (2011) developed a dementia-related emotional Stroop task in which the time taken to

* Corresponding author at: Institute of Psychiatry, KCL, P078, De Crespigny Park, SE5 8AF, London, UK. Tel.: +44 20 7848 5718.
E-mail address: daniel.mograbi@kcl.ac.uk (D.C. Mograbi).

0028-3932/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.neuropsychologia.2012.05.008

colour name dementia-related (e.g., forgetful and lapse) versus neutral words was compared. Patients with dementia showed the same degree of processing bias, lengthening the time taken to read the dementia-related words, as a caregiver comparison group. This contrasted with markedly reduced awareness of neuropsychological condition, with no correlation between awareness and the Stroop effect. Because the emotional interference effect on such tasks are thought to occur at a pre-attentive processing level (Mogg, Kentish, & Bradley,1993; Ohman , Flykt, & Esteves, 2001) it has been concluded that the results may indicate implicit knowledge of the effects of dementia. Taken together, the dissociation between preserved reactivity and impaired awareness in response to failure can be considered evidence of implicit processing of performance or cognitive deficit. This notion has been incorporated in theoretical models of unawareness in dementia. For example, in the Cognitive Awareness Model (Agnew & Morris, 1998; Hannesdottir & Morris, 2007; Morris & Hannesdottir, 2004) there is an implicit component that bypasses explicit awareness and produces behavioural and affective regulation.

In summary, the above studies suggest that people with AD may be responsive to performance failure in the absence of reported awareness. This study was designed to explore this issue in AD further by investigating another indication of responsiveness during performance failure, namely emotional reactivity. For this purpose, we developed two novel experimental success-failure manipulation (SFM) paradigms in which we manipulated systematically levels of task difficulty to gain experimental control over the degree of success or failure, enabling the same levels of performance to be obtained on the tasks by patients and controls. Two paradigms were developed, one with a reaction time procedure and another with memory, in order to determine the extent to which results would generalise across types of task, with the two procedures selected on the basis that their difficulty level could more easily be titrated. Previous research has shown that emotional reactivity in early AD shows relative preservation; although identification of emotions may be impaired, for example in paradigms using facial expressions (McLellan et al., 2008), reactivity to affect-laden stimuli is preserved, as shown in studies employing pictures (Burton & Kaszniak, 2006, Eling , Maes, & Van Haaf, 2006) and films (Henry , Rendell, Scicluna, Jackson, & Phillips, 2009; Smith, 1995). It follows that the main prediction of the current study was that, despite showing markedly reduced reported awareness of performance levels, AD patients would show the same level of emotional responses, assessed by self-report and rating of filmed facial expressions, as control participants.

2. Methods

2.1. Participants

Twenty three participants with mild to moderate AD were included in the study, recruited either from the South London and Maudsley/Institute of Psychiatry Biomedical Research Centre (BRC) Dementia Case Register or from the St George's Healthcare NHS Trust (London) Dementia clinic. Diagnosis was made using DSM-IV criteria for Dementia of the Alzheimer's type (American Psychiatric Association, 2000), with Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) scores of 18 or above (Mungas, 1991; NICE, 2006). Consecutive patients who fulfilled the study eligibility criteria were approached. Twenty one control participants were recruited from the same general area as members of the AD group, screened for cognitive impairment and abnormal memory loss using the MMSE and CERAD (Morris, Heyman, Mohs, & Hughes, 1989) word list tests.

Both groups were aged 65 years or more. Exclusion criteria were no current neurological disorder (other than AD in the patient group, also excluding cases with mixed AD and vascular dementia); history of head injury resulting in loss of consciousness for more than an hour; history of alcohol or substance abuse (based on ICD-10 criteria); and history of diagnosed major psychiatric illness or current comorbidity (for example, mood disorder).

The two groups were matched on age, years of education and gender ratio (see Table 1). MMSE scores and CERAD memory test measures were significantly lower for the AD patients.

Table 1
Background variables divided by group.

Variable	AD group ($n=23$) Mean (SD)/Range	Control group ($n=21$) Mean (SD)/Range	p-value
Age	80.4 (6.8)/66–89	78.6 (6.6)/69–90	.348
Gender[a]	14/9	15/6	.460
Years of education	11.3 (3.1)/4–18	12.0 (3.3)/6–18	.445
MMSE	23.2 (3.1)/18–29	28.5 (1.3)/26–30	< .001
CERAD Immediate recall	11.5 (4.0)/2–19	21.6 (3.8)/13–28	< .001
CERAD Delayed recall	1.4 (1.3)/0–4	7.3 (1.5)/4–20	< .001
CERAD Recognition	15.1 (3.4)/9–20	19.7 (0.6)/18–20	< .001
CERAD # of Intrusions	2.2 (1.8)/0–6	0.5 (0.9)/0–3	< .001

[a] # female/male; Analysis of differences in the gender variable using chi-square test; other analyses using *t*-tests.

2.2. Procedures

Two success–failure manipulation (SFM) computerised paradigms were developed, one based on reaction time and the other on memory, each having two parallel versions made distinctive by non-essential task features (see descriptions below). The ability of the participant was first established individually by systematically increasing difficulty levels until consistent failure occurred. The success or failure conditions were established by setting the difficulty level either above or below this performance threshold. Participants were not informed that levels of difficulty would be manipulated.

The order of experiments and conditions was quasi-counterbalanced between the participants, according to the following factors: Experiment 1 (reaction time) or Experiment 2 (memory) first; success or failure condition first in each experiment; and version allocated for success or failure, in each experiment. Counterbalancing was constrained by not allowing two success or failure conditions in a row. In total this created 16 combinations and each participant was assigned a combination at random without replacement for the overall set, starting again with the next set of combinations for the remaining participants.

2.2.1. Experiments

The tasks were run on a laptop computer with a 17″ screen and external speakers.

2.2.1.1. Experiment 1—Reaction time. In version 1 there was a warning tone and after 164 ms a car appeared on the screen moving across the screen from left to right, with the participants having to 'stop' the car as soon as it appeared by pressing a single centrally located button on a button box. If pressed in time, a 'traffic warden' appears and there is a 'clink' noise. In version 2 after the same warning tone, objects (e.g., ball, egg or vase) appeared to fall from the 'top' of a building and participants had to 'catch' the object by pressing the button, success signified by a 'hand' appearing and the same 'clink' noise. In both cases a buzzer signalled failure to respond in time. Participants were told not to press the button before they saw the target or between trials. Difficulty overall was manipulated by varying the object's speed, quantified by pixels moved per screen refresh, from 12 (slowest) to 42 (fastest).

2.2.1.2. Experiment 2—Memory. The procedures were based around span tasks. For version 1, between 1 to 10 identical everyday objects (taken from a set of photographs; e.g., alarm clocks and baskets) were displayed scattered across the screen. For each trial the objects were highlighted in a random sequence using a red square surround and immediately after participants had to point to the same objects in sequence. For version 2, participants had to listen to a sequence of digits ranging from 0 to 9, also presented individually visually in the centre of the screen, and immediately repeat it back sequentially to the experimenter. For both versions, completely correct responses were indicated by a green visual 'tick' and an auditory 'clink', and failure by a red cross and a buzzer. The shortest sequence was one and the longest 10 objects/digits.

2.2.2. Phases

All tasks had the same following phases:

Practice trials. There were four instructional/practice trials at low difficulty levels for each version. After the last trial the screen showed the words "End of Practice".

Titration. This phase took place at the beginning of the actual task and established a success/failure threshold for each participant by increasing the difficulty level