UEAR #536750, VOL 37, ISS 1

REMEMBERING RELATIONSHIPS: PRESERVED EMOTION-BASED LEARNING IN ALZHEIMER'S DISEASE

Cathryn E. Y. Evans-Roberts and Oliver H. Turnbull

QUERY SHEET

This page lists questions we have about your paper. The numbers displayed at left can be found in the text of the paper for reference. In addition, please review your paper as a whole for correctness.

Q1: Au: Would you like to use "Evans-Roberts" in the correspondence address as well, to be consistent with the article opener?
Q2: Au: Bechara, 2004. Not listed in references. Please add here or delete there.
Q3: Au: Please note the heading "Participant" has been deleted, "Clinical Participant" and "Control Participants" changed to level 2, to avoid too many levels of text headings.
Q4: Au: Please cite Table 2.
Q5: Au: Please define or spell out EBL.
Q6: Au: Please note a few journal/article titles have been changed from UK to US spelling according to corresponding entries in PubMed.
Q7: Au: Maia & McClelland. Should the journal title be ***Proceedings of the National*** [not Natural] ***Academy of Sciences of the United States of America***?
Q8: Au: Tranel & Damasio, 1990. End page?

TABLE OF CONTENTS LISTING

The table of contents for the journal will list your paper exactly as it appears below:

Remembering Relationships: Preserved Emotion-Based Learning in Alzheimer's Disease
Cathryn E. Y. Evans-Roberts and Oliver H. Turnbull

3b2 Version Number : 7.51c/W (Jun 11 2001)
File path : P:/Santype/Journals/TandF_Production/UEAR/v37n1/UEAR536750/UEAR536750.3d
Date and Time : 25/11/10 and 17:52

Experimental Aging Research, 37: 1–16, 2011

ISSN: 0361-073X print/1096-4657 online
DOI: 10.1080/0361073X.2011.536750

Routledge
Taylor & Francis Group

REMEMBERING RELATIONSHIPS: PRESERVED EMOTION-BASED LEARNING IN ALZHEIMER'S DISEASE

Cathryn E. Y. Evans-Roberts
Oliver H. Turnbull

North Wales Clinical Psychology Programme, School of Psychology, Bangor University, Bangor Wales, UK

Research into Alzheimer's disease has long focused on cognitive impairments. Advocates of the person-centered approach argue that emotions and interpersonal responses may *remain intact. The answer to this paradox may derive from the neuropsychology of emotion, demonstrating preserved ability on simple emotion learning tasks, though this may not capture the complex interpersonal interactions that some patients appear able to manage in everyday life. This study demonstrates, for the first time, preserved complex emotion-based learning capacity, despite profound episodic memory impairment in Alzheimer's disease. These findings offer a starting point for the development of a solid neuropsychological and neuroanatomical account for the person-centered approach.*

In recent years the traditional neuropsychological view of Alzheimer's disease (AD) has been challenged by clinicians whose experience of working with people with dementia has highlighted the limitations of an exclusively cognitive approach (Downs, 1997; Kitwood & Benson, 1995; Kitwood, 1997; Mills, 1997; Sabat & Collins, 1999; Woods, 2001). It has been argued that despite the progressive memory loss, and other cognitive impairments caused by the process of AD, the "person" still appeared to be present (Kitwood, 1997; Post, 1995). This led to the development of a person-centered philosophy

Received 5 June 2009; accepted 14 September 2009.
Q1 Address correspondence to Cathryn E. Y. Evans-Roberts, North Wales Clinical Psychology Programme, School of Psychology, Bangor University, Bangor, Wales LL57 2AS, UK. E-mail: cathryn2001uk@yahoo.co.uk

of dementia care, with an increasing focus on the experience and perspective of the person with dementia (Kitwood, 1997).

This person-centered movement raised the question of the importance of episodic memory in relation to the "essence" of what makes us a human being (Kitwood, 1997). Those working with people with dementia claimed that despite the episodic memory impairments, the feelings, emotions, and interpersonal responses of someone with dementia appeared to remain intact (Kitwood & Benson, 1995). It has been argued that people with dementia "still remember love; they are still able to express and experience love, and to form new and lasting relationships" (Bell & McGregor, 1995, p. 14). For example, Sabat and Collins (1999) describe a client who despite demonstrating profound recent episodic memory problems, still interacted with people at her day care center warmly, greeted the authors with "smiles and expressed pleasure at seeing them" (p. 15). Interestingly, not all of the interpersonal interactions were positive; for example, she also displayed a consistent irritation with a particular volunteer at the service.

This anecdotal evidence of the capacity to acquire new emotional knowledge, including the ability to form new interpersonal relationships, is not incorporated in the traditional neuropsychological deficit model, which implies that without cognition we lose our personality and identity (e.g., Cohen & Eisdorfer, 1986; Wilcock, 1990). However, the solution to this paradox, and perhaps the empirical basis for the person-centered philosophy, may lie in findings from the modern literature of the psychology of emotion.

Emotion and Alzheimer's Disease

In the last two decades there has been a developing interest in the cognitive aspects of emotion in AD (Allender & Kaszniack, 1989; Bucks & Radford, 2004; Cadieux & Greves, 1997; Koff, Zaitchik, Montepare, & Albert, 1999). Findings in the literature are inconsistent, although it appears that basic emotion processing may be relatively preserved in AD (Bucks & Radford, 2004). This includes emotional expression (e.g., Magai, Cohen, Gomber, Malatesta, & Culver, 1996; Roberts, Ingram, Lamarm, & Green, 1996; Testa, Beatty, Gleason, Orbelo, & Ross, 2001) and perception of emotion (Fernandez-Duque & Black, 2005; Luzzi, Piccirilli, & Provinciali, 2007; Ogrocki, Hills, & Strauss, 2000; although see Kohler et al., 2005). In addition, emotion has also been found to *enhance* episodic memory in people with AD (Kazui et al., 2000; Moayeri, Cahill, Jin, & Potkin, 2000). These findings may in some part explain the clinical descriptions of affective capacity in people with AD. However, to fully understand the foundations of

the person-centered approach, we also need to consider the rapidly developing literature on the neuropsychology of emotion, especially research focusing on independent emotion systems in the brain.

Independence of Emotion Systems

Emerging evidence suggests that emotion-based systems that are anatomically and functionally distinct from cognitive systems such as episodic memory (Damasio, 1994; LeDoux, 2000; Panksepp, 1998; Rolls, 2000) are mediated by subcortical emotion-related brain areas, such as the amygdala (Davidson & Irwin, 1999; LeDoux, 2000; Panksepp, 1998; Rolls, 2000). Functionally, many patients with amnesia are able to acquire and retain emotion-based material, despite profound impairment of episodic memory (see Eichenbaum & Cohen, 2001, for review), including consistent negative and positive feelings towards people they do not consciously remember (e.g., Johnson, Kim, & Risse, 1985; Tranel & Damasio, 1990, 1993; Turnbull & Evans, 2006; Turnbull, Zois, Kaplan-Solms, & Solms, 2006).

Findings of simple implicit emotion-based learning have been demonstrated in people with AD (Blessing, Keil, Linden, Heim, & Ray, 2006; Willems, Adam, & Van der Linden, 2002; Winograd, Goldstein, Monarch, Peluso, & Goldman, 1999). However, this simple form of learning does not capture the kind of interpersonal interactions that are experienced in everyday life. Such interactions are based on more complex patterns of valence, where individuals can be perceived as both good and bad at different times (Barraclough, Conroy, & Lee, 2004). During such interpersonal interactions, emotion-based learning systems appear able to form an overall aggregate assessment of whether an individual is generally "good" or "bad," based on a wide range of emotional experiences associated with that particular person (Bechara, Damasio, Damasio, & Anderson, 1994; Bowman & Turnbull, 2004; Damasio, 1994). This implicit evaluation generates a feeling (perhaps the experience we describe as intuition) of whether someone is generally a good person or not (Turnbull & Evans, 2006).

Measuring Complex Emotion-Based Learning

The majority of such research has focused on the Iowa Gambling Task (IGT; Bechara et al., 1994), where participants are required to repeatedly select cards from four decks. Each selection produces financial gains or losses, unpredictably scheduled, so that some decks that give high aggregate winnings will lead to an overall financial loss, and vice versa. The task is complex, making it impossible to explicitly

recall the consequences of every card selection (Bechara, Damasio, & Damasio, 2000), though participants gradually form an emotional feeling of which decks are good or bad. This process arguably mimics the type of emotion-based learning that occurs during interpersonal interactions in everyday life (Bechara, 2004).

It has long been argued that participants use emotional feelings of which decks are good or bad to guide their choices (Bechara et al., 1994; Bechara, Tranel, Damasio, & Damasio, 1997; Damasio, 1994). This emotion-based learning clearly appears to involve the same neural architecture of that which underpins traditional emotional experience (Bechara, Damasio, Damasio, & Lee, 1999; Bechara et al., 2000), though the magnitude and nature of this experience may differ from that which other literatures describe as emotion (e.g., Magai et al., 1996; Mills, 1997). Such learning is based on relatively *low* levels of emotional activation, which may be partially implicit in nature (Bowman, Evans, & Turnbull, 2005; Evans, Bowman, & Turnbull, 2005; Maia & McClelland, 2004).

Therefore, one might predict that despite profound episodic memory impairments, some people with dementia may still have preserved complex emotion-based learning capacity, explaining the anecdotal reports that people with dementia seem to be able to acquire and retain new emotional knowledge in everyday life (Bell & McGregor, 1995; Sabat & Collins 1999). This dissociation between episodic memory and emotion-based learning has been demonstrated in neurological patients with nondementing pathologies (e.g., stroke patients; Turnbull & Evans, 2006). However, there have been no formal investigations of this important scientific question in people with dementia. The present study investigated this question by exploring the performance of a person with AD, Mr. A, who had profound episodic memory impairments, on a task of complex emotion-based learning. Mr. A performed the IGT on three occasions, spaced equally over 3 weeks. It was hypothesized that Mr. A's performance on the IGT would not be significantly different from that of the control sample. Thus, it was predicted that Mr. A would be able to learn on a task of emotion-based learning, despite his profound episodic memory impairment.

METHODS

Ethical approval for this study was obtained from North West Wales National Health Service (NHS) Trust Research Ethics Committee. The authors complied with the American Psychological Association (APA) ethical standards in the treatment of their human sample.

Q3 *Clinical Participant*

Case Description and Neuropsychological Profile

Mr. A, a 71-year-old man, was referred to this research study by nursing staff working at an Older Adult Day Hospital. He had received a diagnosis of dementia of the Alzheimer's type in 2002, by a Consultant Psychogeriatrician. Mr. A had no history of neurological problems or severe mental illness. He had been married for over 40 years, had two grown up children, and worked as a clergyman before he retired. Mr. A began experiencing memory problems in 2000, 8 years before this study was carried out. His wife reported that he had previously had a very good memory but she noticed he was having difficulty recalling his sermon and the names of parishioners. His most recent computed tomography (CT) scan in 2004 was normal.

He was assessed for this study in early 2008, at this time he was living at home with his wife. He was not taking acetylcholinesterase inhibitors, due to adverse side effects. Mr. A's wife reported that his memory for recent events had declined significantly in the past 8 years, and was now extremely impaired. Mr. A was able to remember his name, date of birth, birthplace, and mother's maiden name. However, he displayed marked disorientation for time, and was unable to correctly name the day, month, or year. In addition, he could no longer write clearly or spell correctly, and could no longer leave the house alone because he had forgotten his way home on a number of occasions. During the assessment period, Mr. A was unable to recall the investigator's previous visits, or the tasks he had completed in prior sessions.

Neuropsychological Assessment of Memory

Mr. A's memory and learning ability were assessed using the Wechsler Memory Scale—III (WMS-III; Wechsler, 1997). The WMS-III provides a detailed analysis of immediate and recent memory function using both auditory and visual stimuli, and includes normative data up to 89 years of age (see Table 1).

Mr. A displayed a profound impairment of verbal and visual recent episodic memory. For example, immediately after being told a story, he was able to recall 3 out of 25 possible pieces of information. He was also unable to immediately recall any aspects of a visual recall memory test. He had no explicit recall of material from either subtest after a 25-min delay, and in fact could not even remember the subtests being administered. Mr. A's verbal and visual immediate working memory abilities were also impaired, although significantly better than his recent memory capacity.

Table 1. Mr. A's raw and scaled neuropsychological assessment scores

	Raw scores	Scaled scores
WMS-III		
Measures of recent episodic memory		
Logical Memory Immediate Recall	3/75	Scaled score 1
Logical Memory Delayed Recall	0/50	Scaled score 1
Logical Memory Recognition	15/30 (where 15 is chance)	
Family Pictures	0/64	Scaled score 1
Family Pictures Recall	0/64	Scaled score 1
Measures of immediate/working memory		
Digit Span	5 items forwards, and 3 backwards	Scaled score 5
Spatial Span	4 items forward, and 3 backwards	Scaled score 4
D-KEFS		
Measures of executive functioning		
Verbal Fluency Test	F (7) A (9) S (13)	Scaled score 9
California Trail-Making Test		
– Visual scanning		Scaled score 6
– Number sequencing		Scaled score 1
– Letter sequencing		Scaled score 1
– Number-letter switching		Scaled score 1
– Motor speed		Scaled score 1

Neuropsychological Assessment of Executive Functioning

Mr. A's executive function abilities were assessed using subtests from Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001). These tests provide a basic assessment of executive function in both verbal and spatial modalities, and include normative data up to 89 years of age (see Table 1).

Assessment of Mr. A's executive functioning was limited by his memory-related impairments. His memory impairment impacted on his ability to complete tests with complex instructions (e.g., California Card Sorting Test), and he had difficulty understanding the rules of some subtests (e.g., Stroop Test). In addition, he had psychomotor retardation and fatigued easily. Despite these impairments, Mr. A performed within the normal range on a simple measure of Verbal Fluency. However, his test scores were impaired on the Trail-Making Test. Qualitative analysis of his performance suggested that his poor score was due to psychomotor retardation, as he was able perform each trial correctly, including the set-shifting subtest.

Comment on Neuropsychological Assessment

In sum, Mr. A displayed a profound impairment of recent episodic memory, regardless of auditory or visual format. His performance

on tasks of immediate/working memory was also impaired but significantly better than his recent memory performance. This memory profile is typical of someone with AD.

Assessment of Mr. A's executive functioning was complicated by his memory-related impairments. However, he performed within normal limits on a task of verbal fluency, and was able to correctly complete a trail-making task, including the set-shifting subtest. His executive abilities were certainly less impaired than his episodic memory functioning.

Family Interview

Mr. A's wife was asked four questions designed by the investigator to access anecdotal information about his capacity to acquire and retain new emotional knowledge in every day life.

1. Does Mr. A recognize the identity of people he has known for a long time (e.g., over 30 years)? Mrs. A reported that her husband was able to recognize family and friends they had known for over 30 years.

2. Have you noticed a change in Mr. A's feelings for people he has known over a long time? Mrs. A reported that her husband's feelings for these people were unchanged.

3. Is Mr. A able to recognize the identity of people he has met recently (e.g., since the onset of memory problems)? Mrs. A reported that her husband had formed new relationships with people he had met in recent years (over the last 5 years). However, he was unable to recognize the identity of these friends and acquaintances.

4. Does Mr. A's feelings for people he has met recently appear consistent over time? Mrs. A described that her husband's feelings towards these recent friends and acquaintances remained consistent. For example, Mrs. A commented that her husband had formed a close friendship with three people who also had a diagnosis of AD. Although he could not recognize these friends, or recall previous conversations, once reintroduced they consistently got on well. Interestingly, the relationship appeared to develop over time and they now often discussed the emotional impact of their diagnosis and provided support for each other. Interestingly, not all of Mr. A's recent interpersonal interactions were positive. Mr. A displayed a consistent dislike for a particular doctor after a difficult appointment, despite not being able to recall the specific event.

The investigator also observed a difference in Mr. A's interpersonal behavior across the five sessions. Initially he presented as slightly anxious. However, as the sessions increased Mr. A became increasingly friendly towards the investigator. This change in interpersonal behavior over time occurred despite Mr. A's inability to recall the assessor's previous visits.

Comment
The interview with Mr. A's wife and the investigator's observations provide interesting anecdotal information about Mr. A's emotion-based learning capacity. It appears that Mr. A is able to acquire and retain new emotional knowledge about interpersonal relationships, this stands in sharp contrast to his episodic memory impairment.

Control Participants

Ten control participants, aged 65 years or older, were recruited through the Bangor University Community Participant Panel (see Table 1 for participant characteristics). Control participants had no history of neurological problems or severe mental illness. Control participants ranged in age from 65 to 79 years (Mr. A was 71), and had between 12 and 15 years of formal education (Mr. A had 14 years of education).

Iowa Gambling Task (IGT)

Mr. A and the control participants were assessed using the standard administration procedure for the IGT (Bechara et al., 1994). Participants selected cards, in any order, from any of four decks (A, B, C, and D). They were given a £2000 loan in play money and told that the goal was to win as much money as possible. Decks A and B were disadvantageous, and decks C and D were advantageous. The frequency of reward and punishment differ for each deck. Participants won £100 with each card turn from decks A and B, but some cards also incurred losses of between £150 and £1250, such that sustained selection from either of these decks resulted in overall financial loss. Participants always won £50 with each card turn from decks C and D, but some cards also incurred losses of between £20 and £250, such that sustained selection resulted in overall financial gain. Losses were more frequent on decks A and C, than on decks B and D. The task was terminated after 100 card selections.

The Gambling Task was administered on three occasions, spaced one-week apart. As in Turnbull and Evans (2006), the contingencies of the task were altered between sessions to counteract the simple effects of learning. In Session 1, decks C and D were advantageous; in Session 2, decks A and D were advantageous; and in session 3, decks A and B were advantageous.

RESULTS

Control Participants

As in Bechara et al. (1994), for each administration of the IGT the 100 card selections were subdivided into five blocks of 20 cards. The net score of each block was calculated by subtracting the number of good from bad card selections [(C + D) − (A + B)].

To investigate the performance of the control group on the Iowa Gambling Task, the data were subjected to a two-factor (session × block) repeated measures analysis of variance (ANOVA). Follow-up tests were conducted on any significant effects. Mauchly's test of sphericity was assumed for the session main effect and the session by block interaction. However, it was not assumed for the block main effect, therefore the Greenhouse Geisser epsilon was used to adjust the degrees of freedom for the analyses involving the block factor.

The analysis revealed no significant main effect for session, $F(2, 18) = 2.64$, $p = .10$, and no significant interaction, $F(8, 72) = 0.72$, $p = .67$. However, a significant main effect was found for block, $F(1.68, 15.08) = 9.75$, $p = .003$. Due to the serious violation of sphericity (Greenhouse Geisser epsilon = .419), Bonferroni-adjusted (alpha = .005) paired sample t tests were employed to follow up the main effect of block (cf. Stevens, 2002). Follow-up tests indicated significant differences between Block 1 and 4, $t(9) = -4.00$, $p = .003$, and Block 1 and 5 $t(9) = -3.71$, $p = .005$. Visual inspection of the means revealed that, as expected, performance was significantly better at Blocks 1 and 5 in comparison to Block 1 (see Figure 1). No other differences were significant.

Performance of Mr. A Versus Controls

In order to compare Mr. A against the control participants, single–case study t tests were performed. These t tests were specifically designed to allow the comparison of a single case with a small control group (see Crawford & Garthwaite, 2002, for further detail). In the present study, eight single–case study t tests were performed, five t tests exploring learning during individual sessions and three t tests investigating cumulative effects of learning across sessions. When performing multiple analyses, it is good practice to adjust the alpha level using a Bonferroni correction in order to control for Type I errors (although see Pemeger, 1998, for a dissenting voice). Therefore the adjusted alpha level would be .006. However, given the

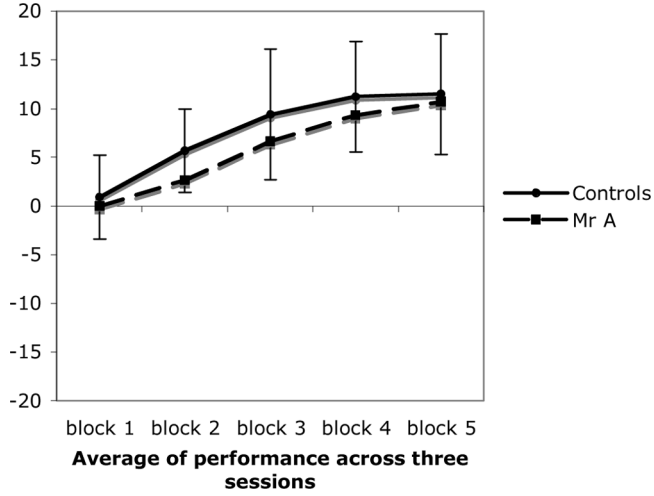

Figure 1. Performance of Mr. A and controls on the Iowa Gambling Task, averaged across three sessions.

hypotheses of the study (i.e., Mr. A's performance would not differ significantly from the control group), it was felt that it was more appropriate to keep the alpha level at .05 for each analysis, thereby adopting a more conservative approach (i.e., the analysis would be more likely to identify significant differences between Mr. A and the controls).

Learning during Sessions

Again, for each administration of the IGT the 100 card selections were subdivided into five blocks of 20 cards. The net score of each block was calculated by subtracting the number of good from bad card selections $[(C + D) - (A + B)]$. For the purpose of this analysis, performance was averaged across the three sessions. A net score above zero indicated that the participants were selecting cards advantageously.

For control participants and Mr. A, performance levels began close to chance and then the selection of advantageous cards progressively increased across blocks (see Figure 1). The results of the single case study t tests revealed no significant differences between Mr. A and the control participants across the five blocks (t values ranging from $-.12$ to -0.67, all p values $>.52$). Table 3 displays the associated t and p values for each analysis.

Table 2. Participant characteristics

	Age	Gender	Marital status	Years of education	Neurological history	Psychiatric history
Mr. A	71	F	Married	14	No	No
Control 1	68	F	Widowed	14	No	No
Control 2	67	F	Married	14	No	No
Control 3	75	M	Married	15	No	No
Control 4	76	F	Married	12	No	No
Control 5	72	F	Widowed	12	No	No
Control 6	78	M	Widowed	14	No	No
Control 7	79	F	Widowed	14	No	No
Control 8	65	F	Married	15	No	No
Control 9	70	M	Married	12	No	No
Control 10	65	M	Widowed	14	No	No

Cumulative Effects of Learning across Sessions

For the purpose of this analysis, a net score was derived for each administration of the IGT by subtracting the good from bad card selections $[(C + D) - (A + B)]$ from the 100 card trials. Again, a net score above zero indicated that the participants were selecting cards advantageously.

On each administration of the IGT, Mr. A and the control participants performed substantially above chance (see Figure 2). The results of the single–case study t tests revealed no significant differences between Mr. A and the control participants across the three sessions (t values ranging from -0.17 to -0.54, all p values $>.60$). Table 3 displays the associated t and p values for each analysis.

Table 3. Summary of single-case *t*-test analysis

	t value	*p* value
Learning during sessions		
Averaged block 1	−0.21	.84
Averaged block 2	−0.67	.52
Averaged block 3	−0.39	.71
Averaged block 4	−0.32	.76
Averaged block 5	−0.12	.90
Learning across sessions		
Session 1	−0.44	.67
Session 2	−0.17	.87
Session 3	−0.54	.60

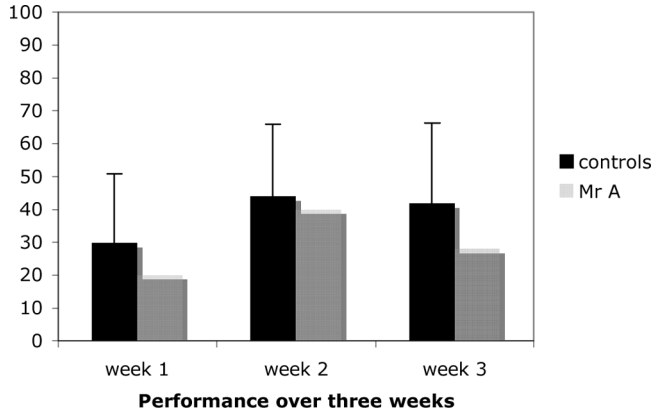

Figure 2. Performance of Mr. A and controls on the Iowa Gambling Task, over 3 weeks.

Further Analyses

There have been recent attempts at dissociating the cognitive processes that may underpin the IGT (Stucco, Fum, & Napoli, 2009), especially as regards the various components of executive function. To investigate this further in Mr. A, we performed two such analyses. Firstly, using an analysis suggested by Stucco et al., we evaluated whether Mr. A had a preference for high versus low frequency of punishment $[(B+D)-(A+C)]$. Mr. A's performance (raw score $=-2.67$, averaged across three sessions) was not significantly different ($p=.62$, $t=-0.51$) to that of the control participants ($M=1.77$, $SD=8.32$, averaged across three sessions). Secondly, to address the issue of perseveration we measured the participant's frequency of deck change. Again, Mr. A's performance (raw score $=89.67$, averaged across three sessions) was not significantly different ($p=.18$, $t=1.47$), from that of controls ($M=46.10$, $SD=28.27$, averaged across three sessions).

DISCUSSION

The central finding of the present study was that of Mr. A's intact performance on the IGT, within a session, demonstrating apparently complex emotion-based learning. His performance over three occasions was also substantially better than chance. Thus, despite profound impairment of episodic memory, Mr. A was able to consistently

display normal levels of emotion-based learning performance. This is the first time this has been demonstrated in people with AD.

This intact performance on a measure of complex emotion-based learning is entirely consistent with the anecdotal information gained during Mr. A's assessment session, and through the family interview. For example, despite an inability to explicitly recall recent events or people, Mr. A appeared able to acquire new emotional knowledge with regards to interpersonal relationships. He demonstrated this ability with several different people including his wife, peers, and health professionals. This ability appeared unchanged despite his progressive decline of episodic memory skills. In addition, his interactions with others appeared entirely consistent with his premorbid personality, suggesting that this ability is not related to a change in his personality but rather it is a preserved skill. Thus, the findings from this novel study provide evidence of preserved emotion-based learning in AD.

A recent issue in the literature (Stucco et al., 2009) has been employing novel data analysis techniques to extract potentially dissociable cognitive processes, related to cognitive control, underlying this measure of emotion-based learning. This issue has never before been investigated in the context of emotion-based learning in AD. Two such further analyses demonstrated that Mr. A was not significantly different from controls depending on the variables of frequency of punishment or perseveration. These data can therefore be viewed in the context of the Stucco et al. distinction of psychological mechanisms underpinning complex EBL. Our evidence suggests that Mr. A has preservation of both the automatic processes sensitive to magnitude and frequency of loss, *and* the cognitively demanding tracking of long-term pay off.

The Person-Centered Approach in Dementia

The findings from this study provide one of the first experimentally robust demonstrations to support the long standing claims from the person-centered literature (Kitwood, 1997; Sabat & Collins, 1999) that people with AD are able to acquire and retain new emotional knowledge, despite progressive memory loss (cf. Blessing et al., 2006). In the present study, Mr. A qualifies as an "existence proof" (cf. Shallice, 1988) of the dissociation between intact emotion-based learning and impaired episodic memory in AD. However, it would be vital to investigate this phenomenon in a larger sample of people with this type of dementia, to enable the better understanding of the incidence rate of preserved emotion-based learning in AD. In addition, it also seems important to adopt a longitudinal approach to explore the impact of the progression of dementia on emotion-based learning capacity.

After many decades of focusing on areas of deficit in AD, we are finally developing an understanding of the domains of preservation in the disorder, including those in the emotional domain. The findings from this study suggest that complex emotion-based learning skills may be intact AD, and offers a starting point for the development of a solid neuropsychological and neuroanatomical account of the person-centered care approach.

Q6 *REFERENCES*

Allender, J., & Kaszniak, A. W. (1989). Processing of emotional cues in patients with dementia of the Alzheimer's type. *International Journal of Neuroscience, 46,* 147–155.

Barraclough, D. J., Conroy, M. L., & Lee, D. (2004). Prefrontal cortex and decision-making in a mixed strategy game. *Nature Neuroscience, 7,* 404–410.

Bechara, A., Damasio, H., & Damasio, A. R. (2000). Emotion, decision-making and the orbito-frontal lobe. *Cerebral Cortex, 10,* 295–307.

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to prefrontal cortex. *Cognition, 50,* 7–15.

Bechara, A., Damasio, H., Damasio, A., & Lee, G. P. (1999). Different contributions of the human amygdala and ventromedial prefrontal cortex to decision-making. *The Journal of Neuroscience, 19,* 5473–5481.

Bechara, A., Tranel, D., Damasio, H., & Damasio, A. (1997). Deciding advantageously before knowing the advantageous strategy. *Science, 275,* 1293–1294.

Bell, J., & McGregor, I. (1995). A challenge to stage theories of dementia. In T. Kitwood & S. Benson (Eds.), *The new culture of dementia care* (pp. 12–15). London: Hawker.

Blessing, A., Keil, A., Linden, D. E. J., Heim, S., & Ray, W. J. (2006). Acquisition of affective dispositions in dementia patients. *Neuropsychologia, 44,* 2366–2373.

Bowman, C. H., Evans, C. E. Y., & Turnbull, O. H. (2005). Artificial time-constraints on the Iowa Gambling Task: The effects on behavioural performance and subjective experience. *Brain and Cognition, 57,* 21–25.

Bowman, C. H., & Turnbull, O. H. (2004). Emotion-based learning on a simplified card task: The Iowa and Bangor Gambling Tasks. *Brain and Cognition, 55,* 277–282.

Bucks, R. S., & Radford, S. A. (2004). Emotion processing in Alzheimer's disease. *Aging and Mental Health, 8,* 222–232

Cadieux, N. L., & Greve, K. W. (1997). Emotion processing in Alzheimer's disease. *Journal of the International Neurological Society, 3,* 411–419.

Cohen, D., & Eisdorfer, C. (1986). *The loss of self: A family resource for the care of Alzheimer's disease and related disorders*. London: W.W. Norton.

Crawford, J. R., & Garthwaite, P. H. (2002). Investigation of the single case in neuropsychology: Confidence limits on the abnormality of test scores and test score differences. *Neuropsychologica, 40,* 1196–1208.

Damasio, A. R. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York: Putnam.

Davidson, R. J., & Irwin, W. (1999). The functional neuroanatomy of emotion and affective style. *Trends in Cognitive Sciences, 3,* 11–21.

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan executive function system*. London: Harcourt Assessment.

Downs, M. (1997). The emergence of the person in dementia research. *Aging and Society, 17,* 597–607.

Eichenbaum, H., & Cohen, N. J. (2001). *From conditioning to conscious recollection: Memory systems of the brain*. Oxford, UK: Oxford University Press.

Ellis, A. W., & Young, A. W. (1988). *Human cognitive neuropsychology*. Hove and London: Lawrence Erlbaum Associates.

Evans, C. E. Y., Bowman, C. H., & Turnbull, O. H. (2005). Subjective awareness on the Iowa Gambling Task: The key role of emotional experience in schizophrenia. *Journal of Clinical and Experimental Neuropsychology, 27,* 656–664.

Fernandez-Duque, D., & Black, S. E. (2005). Impaired recognition of negative facial emotions in patients with frontotemporal dementia. *Neuropsychologia, 43,* 1673–1687.

Johnson, M. H., Kim, J. K., & Risse, G. (1985). Do alcoholic Korsakoff's syndrome patients acquire affective reactions? *Journal of Experimental Psychology: Learning Memory and Cognition, 11,* 27–36.

Kazui, H., Mori, E., Hashimoto, M., Hirono, N., Imamura, T., Tanimukai, S., et al (2000). Impact of emotion on memory. Controlled study of the influence of emotionally charged material on declarative memory in Alzheimer's disease. *British Journal of Psychiatry, 177,* 343–347.

Kitwood, T. (1997). The experience of dementia. *Aging and Mental Health, 1,* 13–22.

Kitwood, T., & Benson, K. (1995). *The new culture of dementia care*. London: Hawker.

Koff, E., Zaitchik, D., Montepare, J., & Albert, M. S. (1999). Emotion processing in the visual and auditory domains by patients with Alzheimer's disease. *Journal of the International Neuropsychological Society, 5,* 32–40.

Kohler, C. G., Anselmo-Gallagher, G., Bilker, W., Karlawish, J., Gur, R. E., & Clark, C. M. (2005). Emotion discrimination deficits in mild Alzheimer's disease. *American Journal of Geriatric Psychiatry, 13,* 926–933.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience, 23,* 155–184.

Luzzi, S., Piccirilli, M., & Provinciali, L. (2007). Perception of emotions on happy/sad chimeric faces in Alzheimer's disease: Relationship with cognitive function. *Alzheimers Disease and Associated Disorders, 21,* 130–135.

Magai, C., Cohen, C., Gomber, D., Malatesta, C., & Culver, C. (1996). Emotion expression in mid-to late stage dementia. *International Psychogeriatrica, 8,* 383–396.

Maia, T. V., & McClelland, J. L. (2004). A re-examination of the evidence for the somatic marker hypothesis: What participants really know in the Iowa Gambling Task. *Proceedings of the Natural Academy of Sciences, 101,* 16075–16080.

Mills, M. A. (1997). Narrative identity and dementia: A study of emotion and narrative in older people with dementia. *Aging and Society, 17,* 673–698.

Moayeri, S. E., Cahill, L., Jin, Y., & Potkin, S. G. (2000). Relative sparing of emotionally influenced memory in Alzheimer's disease. *NeuroReport, 11,* 653–655.

Ogrocki, P. K., Hills, A. C., & Strauss, M. E. (2000). Visual exploration of facial emotion by healthy older adults and people with Alzheimer's disease. *Neuropsychiatry, Neuropsychology and Behavioral Neurology, 13,* 271–278.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human emotions*. Oxford, UK: Oxford University Press.

Pemeger, T. V. (1998). What is wrong with Bonferroni adjustments? *British Medical Journal, 136,* 1236–1238.

Post, S. (1995). *The moral challenge of Alzheimer's disease.* Baltimore, MD: John Hopkins University Press.

Roberts, V. J., Ingram, S. M., Lamar, M., & Green, R. C. (1996). Prosody impairment and associated affective and behavioral disturbances in Alzheimer's disease. *Neurology, 47,* 1482–1488.

Rolls, E. T. (2000). Precis of the brain and emotion. *Behavioral and Brain Sciences, 23,* 177–234.

Sabat, S. R., & Collins, M. (1999). Intact social, cognitive ability, and selfhood: A case study of Alzheimer's disease. *American Journal of Alzheimer's Disease, 14,* 11–19.

Shallice, T. (1988). *From neuropsychology to mental structure.* London: Academic Press.

Stevens, J. P. (2002). *Applied multivariate statistics for the social sciences*. Mahwah, NJ: Lawrence Erlbaum Associates.

Stucco, A., Fum, D., & Napoli, A. (2009). Dissociable processes underlying decisions in the Iowa Gambling Task: A new integrative framework. *Behavioral and Brain Functions, 5,* 1–12.

Testa, J. A., Beatty, W. W., Gleason, B. A., Orbelo, D. M., & Ross, E. D. (2001). Impaired affective prosody in AD: Relationship to aphasic deficits and emotional behaviors. *Neurology, 57,* 1474–1481.

Tranel, D., & Damasio, A. R. (1990). Covert learning of emotional valence in patient Boswell. *Journal of Clinical Psychology and Experimental Neuropsychology, 12,* 27.

Q8

Tranel, D., & Damasio, A. R. (1993). The covert learning of affective valence does not require structures in hippocampal system or amygdala. *Journal of Cognitive Neuroscience, 5,* 79–88.

Turnbull, O. H., & Evans, C. E. Y. (2006). Preserved complex emotion-based learning in amnesia. *Neuropsychologia, 44,* 300–306.

Turnbull, O. H., Zois, E., Kaplan-Solms, K., & Solms, M. (2006). The developing transference in amnesia: Changes in interpersonal relationship despite profound episodic memory loss. *Neuropsychoanalysis, 8,* 199–204

Wechsler, D. (1997). *Wechsler Memory Scale* (3rd Ed.). San Antonio, TX: The Psychological Corporation.

Wilcock, G. (1990). *Living with Alzheimer's disease.* Middlesex: Penguin.

Willems, S., Adam, S., & Van der Linden, M. (2002). Normal mere exposure effect with impaired recognition in Alzheimer's disease. *Cortex, 38,* 77–86.

Winograd, E., Goldstein, F. C., Monarch, E. S., Peluso, J. P., & Goldman, W. (1999). The mere exposure effect in patients with Alzheimer's disease. *Neuropsychologica, 13,* 41–46.

Woods, R. T. (2001). Discovering the person with Alzheimer's disease: Cognitive, emotional and behavioural aspects. *Aging and Mental Health, 5,* 7–16.