

Visual associative learning in Alzheimer's Disease and performance validity

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KNOWLEDGE VALORIZATION

The overall aim of our research was to aid clinicians to better align health care with the memory needs of patients and improve the diagnostic process. For this, clinicians need to be able to assess the extent to which patients with amnesic mild cognitive impairment (a-MCI) and patients with Alzheimer's disease (AD) can still benefit from retrieval support across the continuum of episodic memory impairment. To enable this, we developed new applications of the Visual Association Test (VAT; Lindeboom & Schmand, 2003). First, to monitor the progression of the episodic memory impairment, we developed and validated two extra parallel versions C and D of the VAT (Lindeboom, Schmand, Meyer, & de Jonghe, 2014; Meyer, Spaan, Lindeboom, Schmand, & de Jonghe, 2013). Second, to cover a broad range of episodic memory impairment, we developed and validated the measures of memory of the Visual Association Test-Extended (VAT-E; Meyer & de Jonghe, 2017; Meyer & de Jonghe, 2019). Third, to prevent distortion of test results, we developed and validated the performance validity measures of the VAT-E (Meyer & de Jonghe, 2017). In this chapter we will discuss societal relevance, target groups, products, innovation, and planning and realisation.

1. Societal relevance

The VAT and the measures of memory of the VAT-E enable accurate assessment of memory capacities. This is more important than ever as prevalence of dementia currently is around 50 million cases worldwide and estimated to double every 20 years (Prince et al., 2013; World Health Organization, 2017). Of these cases 60 – 70% is effected by AD (World Health Organization, 2017). In addition, a large portion of demented patients may be non-native speakers, which would struggle with word-list learning tests that are based on the native language and may benefit from a memory test that is based on pictures. In the Netherlands it is estimated that more than 2.5 million persons, i.e. approximately 14.5% of the total

population, grew up speaking a second language besides Dutch (CBS, 2019a; KNAW, 2018). Also, in Europe it is estimated that between 3.7 and 17.8% of adults are non-native speakers, and in the United States of America this is 14.4% (OECD, 2018).

The performance validity measures of the VAT-E enable measurement of memory capacities without distortion of test results by patients who show low performance validity. Prevalence of such low performance validity is estimated to be 6.5% for patients referred to memory clinics (Rienstra et al., 2013), and between 22 and 40% for litigating patients (Larrabee, 2007; Mittenberg, Patton, Canyock, & Condit, 2002). In addition, when subjects are low literate this could confound test results on validity scales such as the Word Memory Test (Green, 2003) where word pairs have to be learned by reading. In such cases, validity scales based on pictures, such as the VAT-E, are more suitable for use. In the Netherlands it is estimated that 1.9 million of adult persons are low literate, i.e. approximately 13.9% of the total population (Algemene Rekenkamer, 2016; CBS, 2019b), and, it is estimated that 15.5% of adults are low literate in Europe, the United States of America, Canada, Australia, South-Korea, Japan, and Russia (Grotlüschen, Mallows, Reder, and Sabatini, 2016).

2. Target audience

Elderly patients may benefit from being administered the VAT or the VAT-E as these tests are more suitable for more vulnerable patients than word list learning tests. Submitting elderly patients to demanding memory tests such as word list learning free recall tests may discourage them, leading to a distorted observation of participation, which is important for clinical assessment of behaviour. Also, extensive assessment of elderly patients with too demanding tests may lead to a distorted representation of the actual memory capacities. By contrast, encoding by means the visual associative learning is less burdensome and taxing for elderly patients, since it facilitates learning more than other memory tests, as it is based on the classic

peg word mnemonic, and pictures of unexpected interactions (Birngruber, Schröter, & Ulrich, 2014; Lindeboom, Schmand, Tulner, Walstra, & Jonker, 2002; Paivio, 1991; Ulrich, Nitschke, & Rammsayer, 2006). Also, the VAT and the VAT-E are easy to administer and promote incidental learning, and the VAT is short.

Patients with dyslexia and patients that are non-native speakers may benefit from being administered the VAT and the VAT-E, since the visual associative learning paradigm is based on pictures. First, the first three performance validity measures of the VAT-E, i.e. immediate recognition, delayed recognition, and the consistency between immediate and delayed recognition, are language-independent during encoding as well as retrieval, although in case of non-native speakers instructions may need to be given by a translator. Second, the VAT and the VAT-E paired associate recall, free recall, and multiple-choice cued recognition are language-independent during encoding, although in case of non-native speakers retrieval responses as well as instructions may need to be given by a translator in case of VAT-E paired associate recall and free recall.

Clinicians may benefit from the varying levels of retrieval support the VAT-E provides. In general, during neuropsychological assessment, memory deficits in patients are measured by means of free recall, which often is contrasted with recognition. Since the measures of memory of the VAT-E include trials of free recall, cued recall, and recognition, the clinician can see at a glance what the memory score profile is of a patient. In addition, clinicians need to measure episodic memory decline in AD to accurately monitor disease progression. The parallel versions C and D in conjunction with the previous versions A and B enable this. Furthermore, clinicians need new performance validity measures, because when the general public becomes knowledgeable about the existing measures and know how they work they become ineffective. The newly developed VAT-E performance validity measures answer this need.

In research, development of medication to cure AD is a spearhead. Longitudinally designed studies in which clinical trials investigate outcome measure results of AD patients during intervention programs may benefit from the repeated measurements that are enabled by the four parallel versions of the VAT.

Health care professionals and informal caregivers may benefit from VAT and VAT-E test results as they could employ memory tools based on the retrieval support a patient can still benefit from. In this way, daily memory functioning of patients can be improved. For example, if visual associative learning is still adequate in patients, health care professionals could learn patients to associate daily living activities with icons, which subsequently could be used by informal caregivers to plan a patient's day in a day planner or on a planning board. Also, if retrieval support based on recognition is still adequate, health care professionals can train informal caregivers to use multiple-choice in conversation.

3. Products

In 2013, we created 12 new VAT items, i.e. parallel versions of the original paired associate recall VAT versions A and B (Meyer et al., 2013). We carefully calibrated the new items to the original based on experimental psychological research (De Groot & Keijzer, 2000; Snodgrass & Vanderwart, 1980; Van Schagen, Tamsma, Bruggermann, Jackson, & Michon, 1983), i.e. we selected concrete objects of high name agreement, high image agreement, high familiarity, and without an American cultural bias. In this way, we selected 24 black and white line drawings, which were tied together by an interaction in 12 new drawings. In addition, we developed a multiple-choice trial for each item (Meyer et al., 2013), which the original VAT does not have. In this multiple-choice trial the target and three distractors are shown. We selected distractors based on experimental psychological research (De Deyne & Storms, 2018; De Groot, 1980; Van Loon-Vervoorn & van Bakkum, 1991), i.e. high

frequency of word association with the target or the cue. A professional artist drew all pictures in accordance with a priori stipulated guidelines to safeguard similarity with the original (Meyer et al., 2013).

The parallel versions C and D of the VAT were published in 2014 by Hogrefe Publishing B.V. Amsterdam (Lindeboom et al., 2014), which is part of the international Hogrefe Publishing Group. In order to make the VAT available for an international audience the manual was translated and published in three languages, i.e. Dutch, English, and German. Currently, almost 400 VAT versions C and D have been sold.

We developed the Visual Association Test-Extended (VAT-E; Meyer & de Jonghe, 2017; Meyer & de Jonghe, 2019) by joining the items of all four VAT versions together, i.e. versions A, B, C and D, and adding trials of immediate recognition, delayed recognition, consistency between immediate and delayed recognition, and free recall. Also, only the parallel versions C and D have a recognition trial, which we used as multiple-choice cued recognition trial for the VAT-E.

The VAT-E was published in 2017 by Hogrefe Publishing B.V. Amsterdam (Meyer & de Jonghe, 2017). The second edition of the VAT-E was published in 2019 (Meyer & de Jonghe, 2019). In the second edition, we included larger norm groups, and a recent study that used the VAT-E performance validity measures in a group of patients with Korsakoff Amnesia (Oudman et al., 2019). Currently, almost 200 VAT-E tests have been sold.

4. Innovation

The visual associative learning paradigm facilitates encoding as it is based on the classic peg word mnemonic, and pictures of unexpected interactions (Birngruber, Schröter, & Ulrich, 2014; Lindeboom et al., 2002; Paivio, 1991; Ulrich, Nitschke, & Rammsayer, 2006). As far as

we know, currently no such neuropsychological memory test exists in the toolbox of the neuropsychologist.

The VAT enables repeated measurements. Many memory tests are available for clinical neuropsychological assessment. Only few of those tests possess parallel versions, which are needed for repeated measurements. The parallel versions C and D of the VAT answer to this need. Assessing patients more than ones is of importance for diagnosis, monitoring intervention outcomes, and assessing conversion from a-MCI to mild AD to more advanced disease stages.

The performance validity measures of the VAT-E are an addition to the toolbox of the neuropsychologist. As opposed to the frequently used Word Memory Test (Green, 2003), it is based on pictures instead of words. As opposed to the side-by-side presentation of stimuli during testing of other visual-based performance validity tests such as the Test of Memory Malingering (Tombaugh, 1996) and the Non-Verbal Medical Symptom Validity Test (Green, 2008), the VAT-E presents visual associations. Also, the Test of Memory Malingering does not have measures of memory, and the Non-Verbal Medical Symptom Validity Test does not have a multiple-choice measure of memory. In addition, neither test employs the embedded performance validity measure free recall compared to multiple-choice cued recognition.

The measures of memory of the VAT-E are an addition to the toolbox of the neuropsychologist. As opposed to the California Verbal Learning Test (Delis, Kramer, Kaplan, & Ober, 1987) the VAT-E is based on pictures instead of words. As opposed to the Free and Cued Selective Reminder Test (Buschke, 1984; Grober, Merling, Heimlich, & Lipton, 1997) the VAT-E is based on incidental learning of visual associations instead of explicit learning of side-by-side presented learning material and has an additional recognition trial. Also, learning material of visual-based memory tests often consists of abstract designs, e.g. Wechsler Memory Scale-IV subtest Visual Reproduction (PsychCorp, 2009; Wechsler,

1945), Rey's Complex Figure Test (Osterreith, 1944; Rey, 1941), and Benton Visual Retention Test (Sivan, 1992), which are less applicable to daily life than the pictures the VAT-E uses, and because these abstract designs have to be recalled by drawing, this may confound test results due to visuoconstructive disabilities.

5. Planning and realisation

The VAT versions C and D and the VAT-E first and second edition have already been published (Lindeboom et al., 2014; Meyer & de Jonghe, 2017; Meyer & de Jonghe, 2019). To further validate and extend norm groups for these tests, data collection is still ongoing at the department of geriatric medicine of the Northwest Medical Center Alkmaar the Netherlands, and the neuropsychological practise of clinical neuropsychologist Dr. J.F.M. de Jonghe. There are several opportunities for further development of the VAT and VAT-E. First, development of a parallel version of the VAT-E and four extra parallel versions of the VAT to enable repeated measurement. Second, digitalization of the VAT and the VAT-E to enable ease of administration and reporting score profiles. Third, translation of the manual of the VAT-E in English and German to promote international availability.

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