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Yamaguchi Fox-Pigeon Imitation Test: A Rapid Test for Dementia

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Key Words
Dementia · Alzheimer disease · Mild cognitive impairment · Psychological burden · Gesture imitation

Abstract
Background/Aims: We herein propose a hand-gesture imitation test, consisting of a simple one-handed sign of a 'fox' and a complex two-handed sign of a 'pigeon', as a rapid, game-like test for detecting dementia/Alzheimer disease (AD) with low psychological burden. The test measures the visuomotor function, which deteriorates in the early stages of AD. ***Methods:*** We examined 88 demented subjects, 19 with mild cognitive impairment (MCI), and 53 normal controls aged 65 years or over. The subjects were classified according to the Clinical Dementia Rating (CDR). ***Results:*** The specificity of the test was 94%, and the sensitivity was 58% in CDR 0.5 (MCI), 77% in CDR 1 (mild dementia), 75% in CDR 2 (moderate dementia), and 90% in CDR 3 (severe dementia). The test could be conducted within 1 min and no subjects refused to be tested. ***Conclusion:*** This brief hand-gesture imitation test can sensitively evaluate visuomotor deficits in dementia/AD, while some subjects are unaware of their failure or even that their cognitive function is being tested. We herein describe the precise protocol for worldwide use.

Introduction

As aging is a major risk factor for dementia, the rapid aging of society leading to large increases in people with dementia will result in a heavy socioeconomic burden. Thus, the early detection and prevention of dementia are urgently required.

We propose a hand-gesture imitation test, as a rapid game-like test, evaluating the visuomotor function for dementia/Alzheimer disease (AD). Although memory deficits are a salient feature of AD, other symptoms appear from the early stages and a representative symptom is visuomotor deficit [1]. Before the onset of clinical symptoms, the bilateral parietal lobes are affected with AD-related pathology [2], and show hypoperfusion as a characteristic single-photon emission computed tomography finding [3]. Thus, gesture imitation, which requires parietal function, may be compromised even in the early stages of AD, a major cause of dementia.

Among gestures, we adopt meaningless nonsymbolic gestures to eliminate semantic components, although some studies insisted that meaningful imitation was more sensitive than meaningless imitation to detect AD [4–6]. However, meaningful imitation recruits semantic processing [7], and the semantic aspects of imitation are preserved in patients with lesions restricted to the pari-

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Table 1. Demographic data, error rate, and error patterns

Classification	CDR	Number	Age years	HDS-R	Error of 'fox' n[1]	Error of 'pigeon' n[1]	Error patterns of 'pigeon'			
							palm-palm n[2]	palm-dorsum, n[2]	dorsum-dorsum, n[2]	intermediate, n[2]
NC	0	53	78.9 ± 5.3	–	0 (0.0)	3 (5.7)	3 (100)	0 (0.0)	0 (0.0)	0 (0.0)
MCI	0.5	19	80.7 ± 7.4	26.5 ± 1.3	0 (0.0)	11 (57.9)	5 (45.5)	1 (9.1)	5 (45.5)	0 (0.0)
Mild dementia	1	39	81.4 ± 6.5	20.2 ± 4.1	1 (2.6)	30 (76.9)	10 (33.3)	6 (20.0)	10 (33.3)	4 (13.3)
Moderate dementia	2	20	82.1 ± 5.4	12.1 ± 3.8	0 (0.0)	15 (75.0)	11 (73.3)	3 (20.0)	1 (6.7)	0 (0.0)
Severe dementia	3	29	81.6 ± 4.0	7.0 ± 5.0	9 (31.0)	26 (89.7)	0 (0.0)	11 (42.3)	12 (46.2)	3 (11.5)
Dementia total	1–3	88	81.6 ± 5.5	14.0 ± 7.3	10 (11.4)	71 (80.7)	21 (23.9)	20 (22.7)	23 (26.1)	7 (8.0)

Figures in parentheses represent percentage. More than half of MCI (CDR 0.5) and 4/5 of demented subjects failed to imitate 'pigeon'. The most frequent error pattern of 'pigeon' was the palm-palm pattern, especially in CDR 0.5–2. HDS-R = Hasegawa's Dementia Scale-Revised (top score is 30, as in the Mini-Mental State Examination).

[1] Errors as a percentage of the total number of attempts.

[2] Each error pattern as a percentage of the total number of errors.

etal lobe [8]. Meaningless gesture imitation examines representation of the body state [9], which is affected by parietal lobe deficits [10, 11]. Thus, we tested meaningless imitation and adjusted the difficulty level according to a previous study showing that complex meaningless gesture imitation can detect AD in the early stages, whereas simple ones cannot [12].

Here, we developed an easy and rapid test, the Yamaguchi Fox-Pigeon Imitation Test (YFPIT), which detects dementia/AD within 1 min. This game-like test reduces the psychological burden associated with ordinary cognitive tests, which often hurts the pride and self-confidence of aged people.

Methods

We tested 160 aged people: 97 in out-patient clinics and 63 in residences for seniors; 41 males and 119 females. The inclusion criterion was being aged 65 years or over. Exclusion criteria were psychiatric diseases, delirium, verbal incomprehension including aphasia, inability to walk, and motor deficits such as paralysis. The Ethics Board of Gunma University School of Health Sciences approved all procedures (No. 21–26), and signed informed consent was obtained from participants or their proxies. Subjects were diagnosed based on criteria for dementia diseases such as National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA). Normal controls (NC) were judged by interviews and questionnaires on frequent symptoms of dementia and instrumental activities of daily living, taken from their family members/carers. Patients and some NC underwent MRI and a set of cognitive tests: e.g. Hasegawa's Dementia Scale-Revised, which is similar and well-correlated with the Mini-Mental State Examination and common in Japan, the cube copying test, clock drawing test, Stroop test, trail-making test, and memory tests. The demented subjects consisted of 64 with AD, 13 with dementia with Lewy bodies, and 11 with other dementia types. In the present study, subjects were classified according to the Clinical Dementia Rating (CDR; table 1). There were no significant differences in age nor gender among the groups (age: $p = 0.11$, 1-way ANOVA; gender: $p = 0.19$, χ^2 test).

The YFPIT consists of a hand-gesture imitation of a 'fox' (fig. 1a) contiguous with a 'pigeon' (fig. 1b). The protocol is as follows:

(1) The examiner sits face-to-face with a subject.
(2) The examiner gives a simple instruction: 'Watch my hand gesture carefully and imitate it.' The instruction can be repeated if necessary.
(3) Then, the examiner makes the 'fox' sign using his/her left hand: fingers III and IV touching the thumb on flexion of the metacarpophalangeal joints with fingers II and V held up (fig. 1a).
(4) The examiner maintains the gesture for 10 s. The subject imitates the gesture concurrently with the examiner. Say nothing during the 10 s of the test. Be careful not to say the words 'fox', or the instruction.
(5) The examiner judges whether or not the subject produces the same sign within 10 s of demonstration; the subject may use either hand.
(6) For 'pigeon', the examiner gives the same instruction, and then makes a 'pigeon' sign using both hands: crossing the hands, palms facing the body, with fingers II–IV extended upward and the two thumbs crossing each other (fig. 1b).
(7) The examiner maintains the gesture without saying anything, especially the word 'pigeon' nor instructions, during the 10 s of the test.
(8) The examiner judges whether or not the subject concurrently makes the same sign within 10 seconds of demonstration.

Points for judgment are as follows:

(a) The direction of the arm and fingers II–V should be upward: hand positions in horizontal or downward directions are judged as failures (fig. 1f).

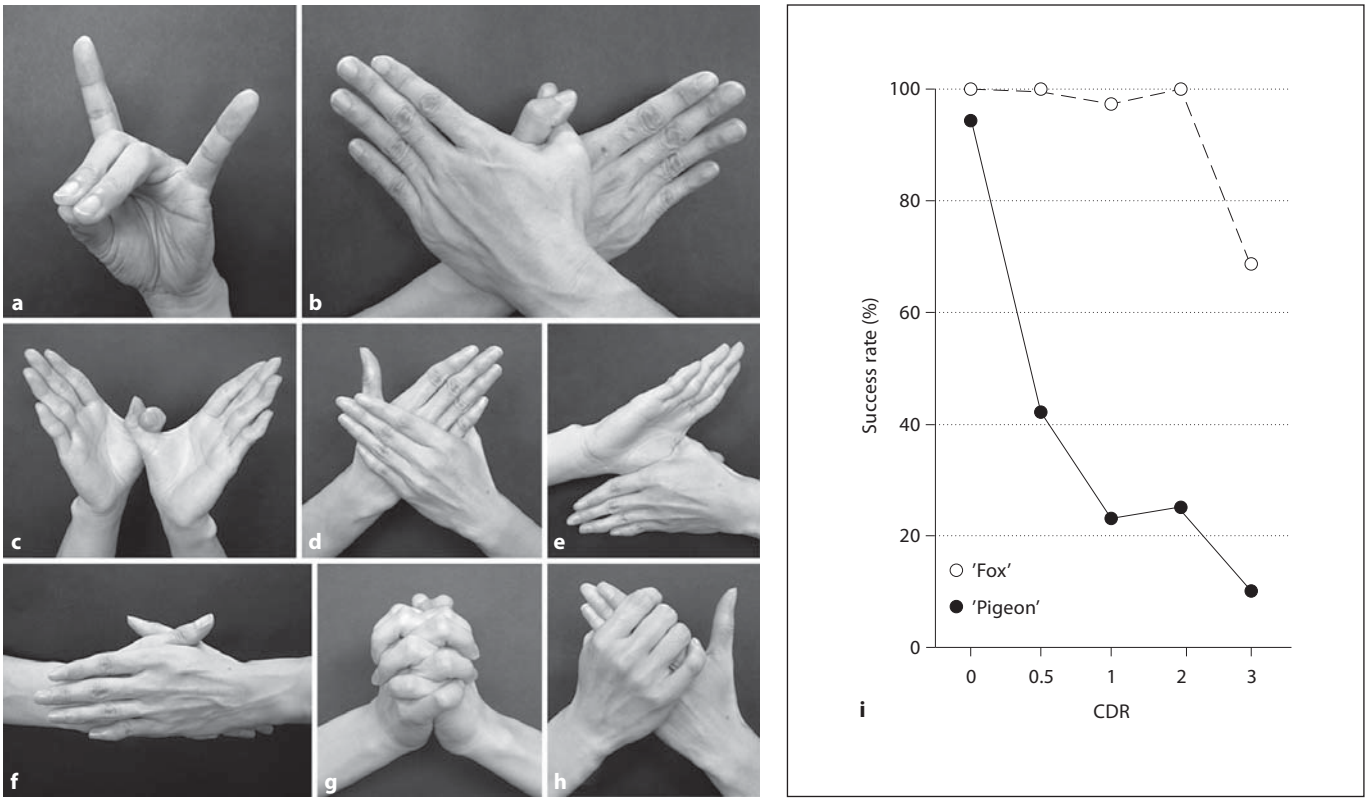

Fig. 1. Hand-gesture demonstration, error responses, and the success rate of the YFPIT according to the CDR. Examiner's demonstration of 'fox' (**a**) and 'pigeon' (**b**). Subjects' typical error patterns of palm-palm (**c**), dorsum-dorsum (**d**), and palm-dorsum (**e**). **f** Error pattern with downward direction of arms. **g**, **h** Error patterns common in CDR 3. **i** The success rate of 'fox' started to decrease at CDR 3, while that of 'pigeon' decreased at CDR 0.5.

(b) Both cases are acceptable: right hand in an outward position or vice versa.
(c) Both palms should be facing the body.
(d) Thumbs should be crossing each other.

Results

Most CDR 0–2 subjects succeeded in imitating the 'fox', whereas 31.0% of CDR 3 subjects failed. No subjects who failed to imitate the 'fox' succeeded with the 'pigeon' (fig. 1i and table 1).

On the other hand, the success rate of the 'pigeon' was 94.3% in NC (i.e. specificity), whereas more than half of the subjects with MCI (CDR 0.5) and 4/5 of demented subjects failed to imitate 'pigeon' (table 1). The error rate was not significantly influenced by age ($p = 0.17$, two-sample t test) nor gender ($p = 0.10$, χ^2). The specificity of the test was 94.3%. In comparison between NC and MCI, the sensitivity was 57.9%, the positive prediction value (PV+; positive diagnosis/test positive) was 86.2%, and negative prediction value (PV–; negative diagnosis/test negative) was 78.6%. In comparison between NC and mild dementia, the sensitivity was 76.9%, PV+ was 84.7%, and PV– was 90.9%. When subjects were limited to the 64 with AD and compared to NC/MCI, the results were similar to those obtained from all demented subjects (online suppl. table 1, www.karger.com/doi/10.1159/000289819). The number of subjects was too small to analyze the differences among the causes of dementia.

As qualitative analysis, we categorized 4 error patterns of 'pigeon' based on the direction of the hands: (1) palm-palm pattern, both palms outward (fig. 1c), (2) dorsum-dorsum pattern, both dorsa outward (fig. 1d), (3) palm-dorsum pattern, one palm and one dorsum outward (fig. 1e), and (4) other patterns. The characteristic error pattern was palm-palm, and subjects showing this error seemed not to notice it, because, from the subjects' per-

spective, they saw their dorsa as well as the dorsa of the examiner (table 1).

Regardless of the hand direction, severely demented subjects showed a tendency to fold their fingers (n = 12, 41.4% in CDR 3), e.g. bring their hands together (fig. 1g), or grip one hand with the other (fig. 1h). Inability to perform 'fox' is also observed mostly among CDR 3 subjects, and, therefore, the rate of subjects showing a folding finger pattern and/or inability to perform 'fox' was 0% in CDR 0.5, 5.1% in CDR 1 (n = 2), and 5.0% in CDR 2 (n = 1), whereas it was 58.6% in CDR 3 (n = 17).

No subjects refused to undertake the test and all finished the test within 1 min.

Discussion

Our results suggest that the YFPIT is useful to detect dementia/AD. The merits of the YFPIT are:

(1) Easy and simple, requiring 1 min.
(2) Enjoyable, like a game.
(3) Nearly half of the subjects with mild to moderate dementia showed a palm-palm pattern, and did not notice their mistakes, preserving self-confidence.
(4) Low error rate of 'pigeon' in NC (5.7%).
(5) High sensitivity for detecting dementia (80.7%).

Adding to the merits for detecting mild dementia, the YFPIT revealed the characteristics of severe dementia; more than half of CDR 3 subjects failed to imitate 'fox' and/or showed a folding finger pattern (i.e. fig. 1g, h) in 'pigeon'.

Why did the YFPIT sensitively detect dementia? The reason is that we adopted a hand gesture, 'pigeon', containing 2 components as follows. One was the component of perspective taking, which is the cognitive process when perceiving a visual scene from one's own perspective (first-person perspective, 1PP), differing from taking a view of the same scene from another person's viewpoint (third-person perspective, 3PP) [13]; 3PP recruits the bilateral parietal area more intensely than 1PP [14]. The most frequent error pattern was the palm-palm pattern, which is related to deficits of perspective taking. In the palm-palm pattern, the subjects see the dorsum of both the examiner and themselves. Another component is body midline crossing, where the hands invade the contralateral space. Making adequate gestures crossing the midline is more complex than making those limited to ipsilateral sides.

As above, with the YFPIT, we successfully detected dementia/AD in the early stages. However, a detection (error) rate of 58% in MCI (CDR 0.5) is insufficient. We do not propose that dementia should be screened with the YFPIT independently. The YFPIT can be one of the components of a test battery for dementia/AD. Questionnaires on instrumental activities of daily living from carers are also important for detecting dementia in its early stages [15]. Combination with other tests is necessary for an accurate diagnosis.

The main issue of MCI is the prognosis of conversion to AD. Imaging studies have reported that hypometabolism and/or hypoperfusion in parietal association areas have a high predictive value of conversion to AD [3], and hand-gesture imitation recruits the bilateral parietal association area. Thus, we assume that the hand-gesture imitation test is useful to predict the conversion from MCI to AD. To evaluate the prognostic role of the YFPIT in MCI, follow-up observation is needed.

Corticobasal degeneration is a progressive movement disorder with cortical and basal ganglionic dysfunction [16], and the hand-gesture imitation test is applied to evaluate the movement disorder [17]. Therefore, failure in the YFPIT can be seen in limb apraxia of corticobasal degeneration as well as ideomotor apraxia of stroke.

Our priority was to devise a simple test protocol – one easy gesture followed by a complex gesture, the difficulty of which is appropriate to distinguish dementia/AD from NC. As a result, more than half of CDR 0.5 subjects failed 'pigeon'. Gesture order is also important. We tested the simple 'fox' before the complex 'pigeon' gesture to rule out deficits caused by the incomprehension of verbal commands or visual deficits. To perform the test as a nonsymbolic imitation, we did not use the words 'fox' and 'pigeon'. Thus, the test evaluated the visuomotor but not semantic function. Previous studies revealed deficits of imitation in AD in the context of apraxia [4–7]. This hand-gesture imitation test, the YFPIT, is an effective 1-min test of dementia/AD, showing good sensitivity/specificity, even though it is quite easy, rapid, and low in psychological burden.

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