Schizophrenia Research 152 (2014) 421–429

Contents lists available at ScienceDirect

Schizophrenia Research

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

Language-dependent performance on the letter fluency task in patients with schizophrenia

Chika Sumiyoshi [a,*], Aygun Ertugrul [b], A. Elif Anil Yağcıoğlu [b], Ajanta Roy [c], Karu Jayathilake [c], Alan Milby [d], Herbert Y. Meltzer [e], Tomiki Sumiyoshi [f]

[a] Faculty of Human Development and Culture, Fukushima University, 1 Kanayagawa, Fukushima, 960–1296 Fukushima, Japan
[b] Department of Psychiatry, Hacettepe University Faculty of Medicine, 06100 Sihhiye, Ankara Turkey
[c] Department of Psychiatry, Vanderbilt University Faculty of Medicine, 2201 West End Ave., Nashville 37235, TN, USA
[d] British Council, Tokyo, 1-2 Kagurazaka, Shinjuku-ku, 162–0825 Tokyo, Japan
[e] Department of Psychiatry and Behavioral Sciences, Northwestern University Feinberg School of Medicine, 446 East Ontario #7-200, Chicago, 60611, IL USA
[f] National Center of Neurology and Psychiatry, 4-1-1 Ogawa-Higashi, Kodaira, 187-8551 Tokyo, Japan

ARTICLE INFO

Article history:
Received 22 October 2012
Received in revised form 23 November 2013
Accepted 15 December 2013
Available online 17 January 2014

Keywords:
Verbal fluency
Letter fluency
Category fluency
Writing system
Cross-language diversity
Schizophrenia

ABSTRACT

Two types of verbal fluency tasks (letter fluency task; LFT, category fluency task; CFT) have been widely used to assess cognitive function in people with psychiatric diseases including schizophrenia. The task demand of the LFT is considered to vary across languages, as the cognitive process largely relies on sound and writing systems. Specifically, a sound unit for a letter (s) and a manner of association between them are assumed to be related with the performance. In the current study, three analyses have been conducted to examine this issue, using Japanese, Turkish, and English-speaking patients with schizophrenia. It was hypothesized that severity of letter fluency impairment would be in the order of Japanese, Turkish, and English speaking patients according to the inflexibility of a word search. First, performance on the LFT and the CFT was compared among Japanese ($N = 40$), Turkish ($N = 30$), and the US ($N = 31$) patients (Analysis 1). A significant difference was found between the US and other two groups only in the LFT. Second, verbal fluency performance was compared between Japanese and Turkish patients by contrasting the degree of disassociations from normal controls (Japanese: $N = 20$, Turkish: $N = 30$) (Analysis 2). In Japanese patients, performance on the LFT was more severely impaired compared to that on the CFT while the opposite trend was found in the Turkish counterpart, suggesting that letter fluency performance was more degraded in Japanese patients. Finally, Analysis 3 was conducted to examine the relative order of letter fluency impairment among Japanese, Turkish and English-speaking patients. Disassociation in English users with schizophrenia was estimated based on previous meta-analytic reviews. The effect size (ES) for the letter fluency deficit was the largest in the Japanese sample, while the other two groups share similar ESs. The results from the three analyses partially supported the hypothesis for the severity of the letter fluency impairment in patients with schizophrenia. The language-dependency of letter fluency impairment was thought to be explained by the theoretical model built on unique properties of sound and writing systems. The considerations presented here would provide useful information for optimizing the portability of cognitive tasks across languages.

1. Introduction

1.1. Factors affecting letter fluency performance

It is widely known that patients with schizophrenia exhibit a wide range of cognitive disturbances. The severity of impairment varies depending on the domains of cognition. Specifically, verbal learning, executive function (e.g. planning, monitoring, inhibition), vigilance/attention, and verbal fluency have been reported to be most severely impaired (Harvey and Keefe, 1997; Reichenberg and Harvey, 2007). A particular disturbance of those domains can be assessed by several types of neurocognitive tasks. Executive function, for example, is typically assessed with Wisconsin Card Sorting Test (WCST), Stroop Test, Trail Making Test (TMT), and/or Tower of Hanoi Test. On the other hand, verbal fluency is measured with just one type of tasks: verbal fluency tasks (VFTs). VFTs are a kind of free recall tasks which consist of the letter fluency task (LFT) and the category fluency task (CFT). In the LFT, subjects are required to generate as many words beginning with a designated letter (e.g. *flower*, *furniture*…, for "F") as many as possible within

Abbreviations: VFT, verbal fluency task; LFT, letter fluency task; CFT, category fluency task; BACS, the Brief Assessment of Cognition in Schizophrenia; PUG, Phonological Unit for a Grapheme; GPC, Grapheme–Phoneme Correspondence; GT Hypothesis, the Hypothesis of Granularity and Transparency.

* Corresponding author. Tel./fax: +81 24 548 8161.
E-mail address: sumiyoshi@educ.fukushima-u.ac.jp (C. Sumiyoshi).

0920-9964/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.schres.2013.12.009

Table 1
Characteristics of sound and writing systems in Japanese, Turkish, and English.

	Phoneme	Examples	Grapheme	Examples	Phonological unit for grapheme (PUG)	Examples	Grapheme–phoneme correspondence (GPC)	Examples
Japanese	Syllable Mora	/ka/, /ta/ /N/, /Q/	Kana	か, た	Large, coarse (Consonant + vowel)	/ka/-か, /ta/-た	Consistent, transparent (one-to-one)	か-/ka/, た-/ta/
Turkish	Consonant Vowel	/k/ /a/	Alphabet	k, a	Small, fine (Vowel, consonant)	/k/-k, /a/-a	Consistent, transparent (one-to-one)	k-/k/, a-/a/
English	Consonant Vowel	/k/, /ɵ/ /ə /, /e/	Alphabet Dygraph	k, a th, ea	Small, fine (Vowel, consonant)	/k/-k, /ə /-a /ɵ/-th, /e/-ea	Loose, opaque (one-to-many, many-to-one)	a-(/ʌ /, /æ/, /ə/, ...) (k, ch…)-/k/

Note: Similar features are highlighted in double line.

a designated time (typically, 1 min). As for the CFT, a category is given as a cue for the retrieval of words (e.g. *dog*, *cat*…for "ANIMAL").

VFTs are included in several neuropsychological batteries for the assessment of cognitive deficits in specific clinical conditions e.g. the Neurosensory Center Comprehensive Examination for Aphasia (Spreen and Benton, 1969), the Multilingual Aphasia Examination (Benton et al., 1994) for aphasia, the Hasegawa's Dementia Scale Revised (Katoh et al., 1991) for dementia, the Brief Assessment of Cognition in Schizophrenia, (BACS; Keefe et al., 2004), and the MATRICS Consensus Cognitive Battery (Nuechterlein et al., 2008) for schizophrenia.

The effect of languages on evaluation for cognitive performance and functional outcome has attracted interest among researchers engaged in global clinical trials for newly developed neuroleptic agents (Harvey and Velligan, 2011; McIntosh et al., 2011; Martini et al., 2012; Velligan et al., 2012). Specifically, the feasibility of LFT has drawn attention from the developers of internationalized neuropsychological batteries, such as BACS (Keefe et al., 2004; Kaneda et al., 2007).

It has been argued that the LFT may require cognitively more intensive processing in non-alphabetical language users (Sumiyoshi et al., 2004; Suga et al., 2011; Dan et al., 2013). Despite an increasing concern for this issue, theoretical considerations for linguistic factors affecting the LFT have rarely been addressed. Although brief comments (Artiola i Fortuny et al., 1998; Harvey et al., 2002) or concise explanations were given in some studies (Sumiyoshi et al., 2004; Dan et al., 2013), more formal and systematic explanations, like the one depicted below, need to be provided.

Performance on the LFT seems to depend on sound or writing systems of relevant languages to a large degree, as subjects need to associate a given letter with sound to search a word beginning with that letter. The cognitive demand, therefore, seems to vary according to the availability of the target sound. To be linguistically precise, the notions of letters (characters) and sound discussed here are termed graphemes and phonemes, respectively. Two factors, a phonological unit for a grapheme (PUG) and grapheme–phoneme correspondence (GPC), appear to be related with the availability.

The PUG represents a minimum unit of phoneme(s) for a corresponding grapheme, i.e. the amount of phonemes a single letter (or multiple letters such as a dygraph) covers (see Table 1 for examples). In the Japanese language, for example, the PUG is typically a syllabic unit consisting of a vowel (V) or a consonant (C) plus a vowel (C + V = CV).[1] In English, on the other hand, generally a single C or V is covered by a letter or digraph (double letters, e.g. "th" for "ea" for /e/) (Table 1). Cognitive demands for word search are considered to vary according to the size of PUG; if a PUG is relatively small, particular combinations like syllables or consonant clusters tend to be formed. In English, for instance, consonant "f" co-occurs with either a vowel (e.g. *family*, *find*, *furniture*,…) or particular consonants, such as "l" (e.g. *fly*, *flower*, *fluent*…) or "r" (e.g. *friend*, *fragile*, *frame*…) (Fig. 1, the top right). Such concurrency of phonemes, like syllabic associations or consonant clusters, can be used as effective clues for searching words beginning with a designated letter. In fact, previous studies have reported that English users exploited this linguistic property on executing the LFT, producing phonologically associated words (Troyer et al., 1997; Robert et al., 1998). Probably, this factor is prominent in languages with rich syllabic structures such as English, in which syllables are formed by chunks of consonants around a vowel (e.g. CCV, CVC, and VCC).

Meanwhile, if a PUG is relatively large, such specific associations are not likely to occur. For example, in Japanese, a syllable does not have specific phonemic partners to appear with (Fig. 1, the top left). In such a circumstance, cognitive demands for word search would become greater, as subjects cannot retrieve words by relying on the concurrency of phonemes. Instead, they just have to enumerate any possible combinations of syllables to find a lexical word.

The consistency in grapheme–phoneme correspondence (GPC) is assumed to be another potential factor affecting letter fluency performance. The GPC considerably varies across writing systems (Table 1). It is rather loose in some alphabetical languages, such as English and Danish, allowing a single grapheme to associate with multiple phonemes. In contrast, other alphabetical languages, such as Spanish, Italian, Turkish, and Serbo-Croatian languages demonstrate fairly consistent GPC with nearly one-to-one grapheme–phoneme correspondence (Oney and Goldman, 1984). Likewise, in the Japanese *kana* system, the association of grapheme (a *kana*) to phoneme(s) (V or CV) is highly consistent, exhibiting almost one-to-one mapping.

Naturally, availability of the target sound in a word search becomes more stringent as the GPC approaches to perfect consistency (one-to-one). That is, finding a word with a specific initial letter would become more difficult if the number of sound alternatives is limited. For example, every Japanese *kana* is exclusively tied with one syllable (or mora), and therefore, it is not possible to search for a word beginning with a specified *kana* by recalling several syllable alternatives (Fig. 1, the bottom left). On the other hand, if a grapheme has more than one phoneme partners, as in alphabetic languages with loose GPC (e.g. English), a subject could search words among several phoneme alternatives, allowing much easier word retrievals. For instance, "a" in English corresponds to /æ/, /ɔ:/, and /ə/ sounds, which provides several candidates beginning with the letter "a" (Fig. 1, the bottom right).

[1] Technically speaking, the PUG in Japanese corresponds to a mora, suprasegmental unit based on duration of sound. Generally, V or CV forms a mora. However, some phonemes (e.g. nasal or geminate sound) exist as morae without syllabic structure but with a full beat like a syllable.