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Oral-diadochokinesis rates across languages: English and Hebrew norms

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ABSTRACT

Oro-facial and speech motor control disorders represent a variety of speech and language pathologies. Early identification of such problems is important and carries clinical implications. A common and simple tool for gauging the presence and severity of speech motor control impairments is oral-diadochokinesis (oral-DDK). Surprisingly, norms for adult performance are missing from the literature. The goals of this study were: (1) to establish a norm for oral-DDK rate for (young to middle-age) adult English speakers, by collecting data from the literature (five studies, $N = 141$); (2) to investigate the possible effect of language (and culture) on oral-DDK performance, by analyzing studies conducted in other languages (five studies, $N = 140$), alongside the English norm; and (3) to find a new norm for adult Hebrew speakers, by testing 115 speakers. We first offer an English norm with a mean of 6.2 syllables/s (SD = .8), and a lower boundary of 5.4 syllables/s that can be used to indicate possible abnormality. Next, we found significant differences between four tested languages (English, Portuguese, Farsi and Greek) in oral-DDK rates. Results suggest the need to set language and culture sensitive norms for the application of the oral-DDK task world-wide. Finally, we found the oral-DDK performance for adult Hebrew speakers to be 6.4 syllables/s (SD = .8), not significantly different than the English norms. This implies possible phonological similarities between English and Hebrew. We further note that no gender effects were found in our study. We recommend using oral-DDK as an important tool in the speech language pathologist's arsenal. Yet, application of this task should be done carefully, comparing individual performance to a set norm within the specific language.

Learning outcomes: Readers will be able to: (1) identify the Speech-Language Pathologist assessment process using the oral-DDK task, by comparing an individual performance to the present English norm, (2) describe the impact of language on oral-DDK performance, and (3) accurately detect Hebrew speakers' patients using this tool.

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1. Introduction

Speech is a very complex motor skill that requires high neuromuscular control and coordination of several systems – respiration, phonation and articulation. Changes in speech production (e.g., rate, fluency and accuracy) can be an early sign for the existence of diseases of the nervous system and motor-speech disorders (Duffy, 1995). Consequently, valid assessment of speech production carries high clinical importance. One of the most common tools for the detection of such changes is the oral-diadochokinesis performance task (oral-DDK). DDK is the ability to perform rapid repetitions of relatively simple patterns of opposite muscular contractions (Baken & Orlikoff, 2000). Oral-DDK is a phonoarticulatory speech task that involves the repetition of syllables composed of a consonant and a vowel (a single syllable, /pa/, /ta/ and /ka/) or of a syllabic sequence (/pataka/) as quickly as possible in a clear manner (Kent, Kent, & Rosenbek, 1987; McClean, 2000; Ziegler, 2002). It is used in order to assess the function of the articulators (tongue and lips). Although it involves actual speech sounds (syllables), it is considered as a nonspeech oral motor task (Ziegler, 2002). Indeed, the orofacial motor function can be evaluated by a non-verbal oral-DDK tasks as well, such as rounding and spreading the lips, and moving the tongue from side to side (Hartelius & Lillvik, 2003). Yet, as the set of syllables in the verbal version of the oral-DDK reflects different places of articulation (bilabial, alveolar and velar), fast and accurate repetitions indicate better control of consonant articulation and speech performance.

The evaluation of speech-motor coordination using the oral-DDK is neither exact nor consistent without a comparison of individual performance to a validated set of norms. Nevertheless, it appears that such norms are missing from the pertinent literature. The current paper aims to rectify this by providing an analysis of existing findings, culled from the literature on English speakers, offering a norm for adult oral-DDK rates (Experiment 1). Moreover, as language and culture might impact articulation rates (see, Jacewicz, Fox, O'Neill, & Salmons, 2009) it is not clear whether an English-based norm suffices, or is there a need to generate norms specific for each different language. For that end, the current study (Experiment 2) also examines the possible impact of language (and culture) differences on the oral-DDK performance, as found in pertinent studies. Finally, we test native-Hebrew speakers (Experiment 3) and present a norm for adults, comparing it to the English one. This will serve to add a missing standard to the literature.[1] Moreover, oral-DDK performance in Hebrew can be taken as a test-case, because of its unique set of similarities and differences from the English language (see Section 1.4).

1.1. Oral-DDK – background

Oral-DDK is also known as Alternate Motion Rates (referring to rapid repetitions of a single syllable, /pa/, /ta/ or /ka/) or Sequential Motor Rates (rapid repetitions of a syllable sequence, such as /pataka/; Darley, Aronson, & Brown, 1975; Duffy, 1995). The rate of oral-DDK, defined as the rate of maximally rapid syllable repetition, is the most common measure of DDK performance and is a standard component of motor speech assessment (Bernthal, Bankson, & Flipsen, 2008). Typically, oral-DDK rate is either gauged by counting the number of repetitions produced in 10 s (or 5 s, 'count-by-time') or by measuring the time taken for producing ten repetitions (or any other number, 'time-by-count'; see, Fletcher, 1972; Kent et al., 1987). Each measure has its shortcomings and advantages (see Ben-David, van Lieshout, & Leszcz, 2011, for a discussion on averaging performance time in a selective attention task), and both are fairly used. Yet, one may note that the 'count-by-time' method presents a time constraint, which induces stress (see an example in emotional Stroop task, Ben-David, Chajut, & Algom, 2012). Some evidence suggests that this may improve the performance of people with speech disorders. For example, people who stutter had less events of disfluency under high time-stress as compared to low time-stress conditions (Peters, Hulstijn, & Starkweather, 1989).

1.1.1. Stimuli

Oral-DDK paradigms vary also in the choice of stimuli. Several different sound sequences were used in the oral-DDK task. The scope of this study does not permit us to review all of them. We focus on one sequence, /pataka/. The ability to accurately sequence these sounds is an important index in different linguistic systems, as they can be found in many langauges. These target sounds, all voiceless plosives, represent varying levels of physiological complexity, indicated by differences in the acquisition age and places of articulation (lips, tongue tip and tongue dorsum, see a detailed description by Ladefoged, 1993). This task assesses a vital ability – to program a sequence of speech movements rapidly and successively. In terms of cost-effectiveness within a therapy session, this task is quick and easy to perform and monitor. Importantly, it does not require any special equipment.

1.1.2. Oral-DDK as an index of speech/articulation rates

The simple nature of the oral-DDK task renders it an efficient first estimate for speech rates in the clinic (as well as a measure of oral-motor abilities). Speech (or speaking) rate is an index of articulatory functions, measured by counting the number of spoken units (words or syllables) over a given time (minutes or seconds), incorporating all forms of pauses, disfluencies and interruptions (Howell, Au-Yeung, & Pilgrim, 1999). Yet the relation between speech and Oral-DDK rates is

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[1] The first author, who has been working as an SLP clinician in Israel for the past 15 years, can indicate from personal experience on the necessity of Hebrew (the main spoken language in Israel) norm for Oral-DDK performance.