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Rapid automatic naming predicts more than sublexical fluency: Evidence from English-French bilinguals

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ABSTRACT

Rapid Automatized Naming is an important predictor of reading fluency. Whether Rapid Automatized Naming measures abstract sublexical correspondence fluency (Theory A) or word-specific fluency (Theory B) is unresolved. English, and to a lesser extent, French orthographies are opaque for reading. Thus, if Rapid Automatized Naming predicts word reading fluency after controlling for within-language pseudoword decoding fluency, in typical English-French bilingual students, theory B is supported over theory A. Hierarchical regression analyses with 76 typical English-French bilingual students revealed that kindergarten Rapid Automatized Naming predicted English word and French word reading fluency in Grade 6 and sometimes in Grade 3 after within-language pseudoword reading fluency was controlled, supporting theory B. However, Rapid Automatized Naming consistently predicted French word and pseudoword reading, supporting theory A. We argue that Rapid Automatized Naming indexes resources for learning both the lexical features of written words and orthography-to-phonology correspondences in opaque orthographies among bilingual students.

1. Introduction

Rapid Automatized Naming (RAN) tasks, which assess the ability to name a serially-presented list of letters, words, colors or objects as rapidly as possible, are important predictors of later reading ability (e.g., Norton & Wolf, 2012). However, what mediates this RAN-reading relationship remains contentious. One well-established path to understanding RAN and its contribution to reading is to assess RAN's predictive power in languages that vary in orthographic depth, typically carried out with monolingual speakers of each language. In the present study, we extended this logic to a group of students educated in both English and French, providing a natural experiment to explore the cross-linguistic role of RAN in two languages often viewed as having deep orthographies, in the same learners. Because the participants were learning both languages in the same broad familial, cultural and scholastic contexts and with the same general constitutional resources (educational history, context, intelligence, attention, general language abilities, broad dispositional and motivation factors, for example), issues of sample comparability that can bedevil cross–linguistic comparisons using different participants are much reduced, if not eliminated, in our study. Below we first consider theories of the role of RAN in English and then across languages to underpin the present study.

1.1. Early predictors of reading ability

Numerous studies have shown that knowledge of grapheme-to-phoneme correspondence (GPCs) along with phonemic awareness (PA) strongly predict reading ability in English (Bond & Dijkstra, 1967; Lervåg, Bråten, & Hulme, 2009). RAN tasks have also been strongly implicated in reading development. In typically developing children, reliable longitudinal correlations between scores on both alphanumeric and non-alphanumeric RAN measures and reading ability have frequently been reported (Bowey, 2005; Kirby, Georgiou, Martinussen, & Parrila, 2010; Lervåg & Hulme, 2009; Wolf & Bowers, 1999).

1.2. Theories of the relationship between RAN and reading

Theories of RAN abound. RAN has sometimes been theorized as a measure of general resources that impact reading - such as processing

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speed (Kail, Hall, & Caskey, 1999), visual processing (Stainthorp, Stuart, Powell, Quinlan, & Garwood, 2010), or serial processing ability (Georgiou, Parilla, Cui, & Papadopoulos, 2013). According to these conceptualizations, RAN reflects general reading-related processing skills and, thus, should not exhibit language-specific effects. Another class of theories sees RAN as tapping sub-processes intimately involved in reading. Below we describe two such theories. Some such models construe RAN as a measure of the efficiency of the use of GPCs or other sub-lexical Orthography-to-Phonology Correspondence (OPC) units (e.g. Manis, Seidenberg, & Doi, 1999), a view that we term Theory A.

Broadly consistent with Theory A, Savage, Pillay, and Melidona (2007) deconstructed the components of RAN in 65 below-average readers and spellers by first analyzing the factorial associations between RAN tasks, pseudoword decoding and a range of processing speed and speeded response measures that required the inhibition of a dominant response (e.g. rapidly naming '1' as '2' and vice versa, in number lists). In preliminary factor analyses, all RAN speeded naming tasks uniquely loaded together as a Rapid Naming factor. A second factor – labeled Alphanumeric Naming, clustered all tasks involving speeded alphanumeric naming and included RAN and all other response speed and speeded inhibition tasks. Finally, alphanumeric RAN tasks loaded with pseudoword decoding as a third factor labeled– Decoding. A second wave of analyses explored the unique associations of these three process latent variables with reading. After chronological age, non-verbal ability and the Decoding factor were first entered, the Alphanumeric Naming factor predicted < 2% of the unique variance and the Rapid Naming factor predicted < 1% of the unique variance in word reading. The Decoding factor explained 50% of the unique variance in word reading. These results suggest that among poor readers, RAN operates on reading primarily through its association with phonological decoding ability, consistent with Theory A above.

Also consistent with Theory A, Moll, Fussenegger, Willburger, and Landerl (2009) note that RAN was as strong a predictor of pseudoword as of real word reading fluency in German students. Moll et al. ran concurrent stepwise regression analyses with 3 samples of monolingual German children (sample 1: $n = 342$, sample 2: $n = 640$ sample 3: $n = 247$). After controlling for chronological age at step 1 and pseudoword reading fluency at step 2 in each sample, they report that RAN explained only 0.05% and 0.07% of unique variance in word reading fluency in the first two (larger) samples and 1.7% of unique variance in the last sample. Arguably, these analyses would benefit from the inclusion of more complete controls (e.g. general verbal ability, phonological awareness, reading accuracy), including controls for the nestedness of data in their large samples. Nevertheless, overall, < 1% of unique variance was explained by the specific RAN-word reading fluency association across > 1000 children. A coherent interpretation of Moll et al.'s data is that RAN primarily underpins the automation of sub-lexical processes that are then used in the fluent reading of both words and pseudowords.

Alternatively, RAN has been viewed as an index of word-specific 'orthographic' and/or word-specific phonological knowledge (Bowers & Wolf, 1993; Decker, Roberts, & Englund, 2013; Powell, Stainthorp, & Stuart, 2014); we term this broad view Theory B.[1] Theory B suggests that RAN taps into a mechanism by which known words are directly and rapidly retrieved from the mental lexicon. Here, RAN has been viewed as a measure of rapid access to lexical phonological representations - verbal labels for words stored in long-term memory (Clarke, Hulme, & Snowling, 2005; Wagner & Torgesen, 1987). From this broad view, RAN predicts reading because the integrity and efficiency of the network involved in mapping objects to their verbal labels may place constraints on the development of a written word-recognition system (Lervåg & Hulme, 2009). The findings that RAN and PA explain independent variance in reading ability, that low correlations are sometimes found between RAN and phonological measures, and that some individuals exhibit reading difficulties despite intact phonological processing arguably suggests that a strongly phonologically-moderated theory of RAN may not be accurate and, thus, provides indirect support for Theory B (Bowers, 1993; Georgiou, Manolitsis, Nurmi, & Parrila, 2010; Savage & Frederickson, 2005).

RAN also probably taps distinct processes related to lexical access and, thus, text reading fluency (Bowers, 1993; Georgiou et al., 2010; Savage & Frederickson, 2005; Young & Bowers, 1995). Savage and Frederickson (2005) found that RAN, but not PA, explained unique variance in passage reading fluency after controlling for passage reading accuracy, suggesting that RAN assesses ongoing word retrieval efficiency during passage reading. Theory B is also supported by evidence from meta-analytic reviews that RAN-reading associations are stronger in languages where orthography-to-phonology patterns are less consistent (Araújo, Reis, Petersson, & Faísca, 2015) and where, on some views, lexical information may be required to resolve pronunciation ambiguities (Schmalz, Marinus, Coltheart, & Castles, 2015). The role of language consistency is considered further below.

1.3. Crosslinguistic modulation of RAN

Alphabetic languages vary in orthographic transparency - the degree of correspondence they exhibit between graphemes and phonemes (e.g., Caravolas et al., 2012; Caravolas & Bruck, 1993). English is a morpho-phonological language and is, thus, considered a 'deep' orthography. It is at the 'opaque' end of the language orthographic transparency-consistency spectrum and has been labeled an 'outlier orthography' (Share, 2008). In the most transparent languages, such as Finnish, which exhibit an almost one-to-one correspondence between graphemes and phonemes (Georgiou, Parrila, Kirby, & Stephenson, 2008; Ibrahim, 2015), almost all readers achieve reading accuracy rapidly (Caravolas, 2005; Everatt & Zabell, 2002; Harris & Hatano, 1999; Seymour, Aro, & Erskine, 2003). In such highly transparent orthographies, the most persistent reading difficulties are related to reading speed, and RAN is often the main cognitive deficit observed in children with dyslexia (Landerl & Wimmer, 2000; Wimmer, 1993; Wimmer, Mayringer, & Landerl, 1998). There also exists evidence from direct comparative studies that RAN predicts reading across a range of European spelling systems but that the relationship is partly moderated by orthographic consistency (Araújo et al., 2015; Vaessen et al., 2010; Ziegler et al., 2010).

There has been some debate about the orthographic transparency of French. It has been asserted that French, unlike English, has relatively high 'feed-forward' consistency from graphemes to phonemes, but similarly low "feed-back" consistency from phonemes to graphemes (Moll et al., 2014, 2009). French is generally not, however, accepted to be a 'transparent' orthography (Borgwaldt, Hellwig, & De Groot, 2005; Caravolas, 2005; Seymour et al., 2003; Ziegler et al., 2010). For example, Seymour et al.'s comparative study reported French as the European language closest to English in terms of orthographic depth and Ziegler et al. reported similar patterns based on calculated 'entropy' values of initial consonants. In such analyses, if a letter always corresponds to one phoneme, its entropy value is zero, and the higher the entropy value, the larger the number of alternate pronunciations of an onset letter. Ziegler et al. report that the entropy value of French is 0.46 which is the next highest after English with 0.83, compared to 0.00 for Finnish, 0.17 for Hungarian, and 0.23 for Dutch. This debate may reflect, in part at least, the impact of the specific measures used to assess opacity, such as vowel consistency (Moll et al., 2009) versus onset entropy (e.g. Ziegler et al., 2010), where these two indices give somewhat different measures of relative opacity, particularly for French (Borgwaldt et al., 2005). Schmalz et al. (2015), argue that the opacity of

[1] As we seek to focus on orthographic and phonological processes in the present paper we elect to exemplify these using a dual route approach. Seidenberg and McClelland's (1989) triangle theory provides a strong alternative to the dual route model but assumes an as yet unimplemented, semantic influence. Semantics is beyond the scope of the present paper.