Phonological Awareness and Visual Attention Span as Predictors of Literacy Development

Panagiota Batsougianni
S2783975

MA in Applied Linguistics
Faculty of Liberal Arts
University of Groningen

Supervisors:
Dr. Merel Keijzer (primary supervisor)
Dr. Hilde Hacquebord (second reader)

Date 7/6/2015
Word count: 15803
Abstract

The present study provides a meta-analysis of the literature concerning phonological awareness and visual attention span (VAS) and their respective contributions to literacy development. Phonological awareness and VAS as constructs are explained along with their involvement in reading and writing. Tasks that are commonly employed for their assessment are also described. Studies that have been produced during the last 13 years are summarized in tables and their main outcomes (i.e. predictive value) vis-à-vis reading and writing development are presented. Both phonological awareness and VAS has proven reliable and independent predictors of literacy skills development. Similarly, deficits in either have often been associated with the emergence of learning difficulties such as dyslexia. According to the available literature both constructs are thus strong predictors of literacy. However, they seem to be two independent factors that explain a significant amount of variance in reading and writing skills. There is not a great number of studies that provide ample evidence for this but what is not yet clear is which of the two can be considered the strongest predictor of literacy success. This meta-study aims at uncovering this. In addition, this meta-study ends in suggestions for further research as well as a discussion of the teaching implication that arise from the outcomes of the studies that have examined the contributions of both phonological awareness and visual attention span to literacy development.

Keywords: Phonological awareness, Visual attention span, literacy development, reading, spelling, dyslexia.
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Chapter 1: Introduction

Throughout the history of language learning as a research field, whether first or second language acquisition, the mechanisms that underlie the process of literacy development have been the object of a considerable amount of research. When considering language development, speaking and reading are the two skills that are perhaps most salient. However, it should not be disregarded that, apart from these abilities, literacy also includes the ability to write (Garton & Pratt, 1998). While a given cohort of school children may all receive the same school instruction, not all students seem to develop the ability to read and spell at the same rate or in the same manner. Moreover, sometimes these abilities are not successfully acquired at all and a language developmental disorder diagnosis may follow. So what is it that prevents some children from attaining reading and spelling skills and which aspects influence literacy development?

The cause of deficiencies in literacy skills as well as the determinants that affect this process have been widely investigated. During the past decades, a number of cognitive abilities have been successfully proven to be especially influential in mapping out the literacy development trajectories of individual children. Phonological awareness is one of the first factors that was identified as a predictor of literacy and deficits, in the sense that defects in phonological awareness were found to be the underlying cause of learning difficulties (Hulme et.al., 2002; Bird, Bishop & Freeman, 1995). Phonological awareness continues to be one of the most robustly and frequently associated predictors of literacy success. In addition to this well-established determinant, past research has resulted in the identification of a number of other predictors of literacy attainment: Rapid Automatized Naming (RAN) as well as Paired Associate Learning (PAL) are considered to be equally
important in determining the outcome of reading and spelling acquisition (e.g. Wagner & Torgesen, 1987; Wimmer, Mayringer & Landerl, 2000; Lervag & Hulme, 2009; Windfuhr & Snowling, 2001; Hulme, Goetz, Gooch, Adams & Snowling, 2007). As such, any deficiencies in any or several of these aspects have been associated with problems in reading and a number of other learning difficulties. Studies have found, for instance, that phonological and short term memory deficits are closely related to learning impairments such as dyslexia and can also “be considered as sub clinical markers of dyslexia” (Gallagher, Frith, & Snowling, 2000). Apart from the “usual suspects” another relatively new factor has more recently come to be added to the list of literacy predictors and has so far shown great explanatory power over the visual attention (VA) span and, more precisely, the VA deficit hypothesis that has recently been related to dyslexia. According to that hypothesis, “letter string deficits” result from an impairment in visual processing rather than from a deficit during the process of “visual-to-phonology code mapping” (Lobier, Zoubrintzky & Valdois, 2011, p.768). In other words, it has been claimed that visual attention is perhaps more important in predicting and explaining literacy deficits or lags than the more traditionally associated phonological awareness factor. However, mixed results have been produced concerning which of the aforementioned factors can account for learning variation in reading.

The purpose of the present study is twofold: it aims to first of all provide an adequate description of both the factors of phonological awareness and the more recently emphasized factor of visual attention. The second part of this study then constitutes a meta-study, in which the various studies that have associated one or both factors with literacy success, are more closely examined. By detailing the background of these studies (their learners, languages, main outcomes, etc.), the effective contributions of both phonological awareness and visual attention can be uncovered. This can lead to a clearer outline of the
topics the future studies should address as well as the factors to control for in literacy investigations. Furthermore, teaching implications will be discussed concerning instructional approaches that assist literacy development as well as provisions that can be made for children that lag behind their peer in literacy success.
Chapter 2: Explaining phonological awareness and VA

Phonological awareness has been widely accepted as a crucial factor in the development of literacy skills. The chapter below first of all focuses on the definition of the construct, as well as the measures that have been used to tap it. It closes by exploring the interpretations past studies have given to both the outcomes of phonological awareness tasks and – related to that – the contribution of it to the construct of literacy success. The second part of this chapter will then do the same for the more recently introduced predictor of VAS that has been claimed to greatly shape the trajectory of literacy development.

2.1 What is phonological awareness?

When exploring the acquisition of literacy skills, the ability of a learner to perceive the various sounds that comprise lexical items seems to be the key factor that underlies this process. Literacy skills such as reading, spelling or writing are actions that rely heavily on one's ability to distinguish among sounds and comprehend the various phonological structures that compose a certain meaning. Nevertheless, the acquisition of these abilities does not happen simultaneously in a child's life but rather in a developmental sequence, where spoken language precedes the ability to read and write (Hulme et al., 2002; Bird, et al., 1995). This has led to the assumption that the extent to which children are aware of the “sound-symbol relationship”, an essential skill in reading development, is proportional to the perception of “spoken language units” (Hulme et al., 2002, p. 3).

For most people learning how to read is simply the ability to match a certain letter to its corresponding sound, and matching up a string of such letters to form a word. However, in reality, a “one-to-one mapping between phonemes and acoustic properties of sections of a speech signal” does not exist, since the eventual articulation of a phoneme is
not predetermined, but depends on the phonemes that surround it as well as on other individual characteristics of the speaker like age, sex and so on (Bird et al., 1995, p. 446).

The language to be learned is another factor that can influence literacy development. Languages that exhibit a higher phoneme-grapheme correspondence (e.g. Turkish, Spanish) facilitate the process of “word decoding” (Oney & Durgunoglu, 1997, p.3). On the other hand, languages that do not have a phonologically transparent orthography- which practically means that what you hear is not always what you write- such as English or French, may constitute a challenge (Oney & Durgunoglu, 1997, p.3). Consequently, it is evident that letters in general do not constitute sound-specific representations, but rather vague sounds influenced by the phonological context (Bird, et.al.,1995). Becoming literate involves the mastery of speaking, reading and spelling skills; yet the acquisition of the latter two is considerably harder since it depends on the conscious employment of knowledge concerning the “phonological structure of syllables”, gained subconsciously in a pre-literacy stage (Bird et al., 1995, p. 445).

According to Bird et al. (1995), past studies have produced a plethora of results in favour of the theory that phonological awareness is a crucial factor in the development of literacy, especially in languages that are considered transparent. Being aware of words' phonological construction assists learners in creating associations between linguistic units (phonemes) and the “graphemes, letters or group of letters” that depict them (Bird et.al., 1995, p.447). The ability to comprehend unfamiliar words relies on this mechanism (Bird et.al., 1995). Moreover, it has been reported that it is this mechanism that young learners employ to figure out the orthography of unknown words (Bird et.al., 1995). Experiments that involve language or intelligence impaired children have also much contributed to provide supportive evidence of the contribution of phonological awareness to the development of these abilities (Bird et al., 1995)
2.1.1 Tasks used to assess phonological awareness.

Studies designed to investigate phonological awareness typically assess the construct using a number of set tasks, or indeed a combination of these. All of these tasks rely on a person's ability to identify the various sounds that exist in a given language. They tap into phonological skills since they directly address the ability to identify a specific phoneme and phonologically manipulate a word. The most frequently employed tasks to tap phonological awareness are as follows:

1. **Phoneme deletion task:** In this task subjects listen to a non-word and then they are requested to omit a certain phoneme and in this process create an existing word out of the non-word. An example of such a task item is “What is jarl without the /l/ sound?” (Warmington & Hulme, 2011, p.51). In another version of this same task participants have to repeat a non-word and then delete a certain phoneme, which in some words appears more than once. The following is an example of this task as described by Van de Boer, de Jong & Haentjens-van Meeteren (2012, p.247): p Repeat gepgral without g”.

2. **Phoneme recognition task:** For the phoneme recognition task, subject are presented with real word pairs. Then they have to decide whether the words in each pair include the same phoneme(s) or not (Talwar, Cote & Binder, 2009). For example, for the word pair *tropical* and *try* a prompt would be, “Do *tropical* and *try* begin with the same sound? Tropical. Try” (Talwar et al., 2009).

3. **Phoneme detection task:** The goal of this task is to find the non-word that has the same phoneme as a given stimulus (Hulme et al, 2002). The conditions may be either “initial consonant and onset conditions”, where participants are presented with the stimulus word and then they have to choose the one that begins with the same sound from a number of three alternatives or “rhyme and final consonant conditions”, with the target this time
being the final sound (Hulme et al., 2002, p.7). Hulme et al. (2002) provide the following example for the onset condition and mention that the same instructions were used for the rhyme condition and the only difference was that participants were asked to focus on the final sound instead. This example constitutes the initial trial used to familiarize subjects with the procedure: "Listen very carefully. Repeat the word you hear following what you hear the computer say. Good, now the computer will say three more words; which one of these other words starts with the same sound as ____.” (Hulme et al., 2002, p.7). After the trial the actual task takes place: "Now this time, the word the computer will say is a silly made up word so you will have to listen very carefully, (e.g., /smi?/). Can you say /smi/?? Good, now the computer will say three more silly words; which one of these other words starts with the same sound as ____ ” (e.g., /suk/ [target] – /klid [distracter]–/nab/ [distracter])?” (Hulme et al., 2002, p.7).

4. **Comprehensive Test of Phonological Processing (CTOPP):** The following subtests are included to assess this phonological awareness (all taken literally from Dickens, Meisinger & Tarar, 2015, p. 156):

   a) Elision: The examinee listens to a word, repeats that word, and then is asked to say the word without a designated sound (e.g., “Say cat without the /c/”)

   b) Blending words: The examinee listens to a series of audio recorded separate sounds and then is asked to blend the sounds together to make a whole word (e.g., “What do these sounds make: b-oi?” The correct response is “boy.”)

   c) Sound Matching: The examiner says a word, pauses, and then says three other words while pointing to drawings that represent all four words. For the first 13 items, the examinee is asked to point to the picture that has the same initial sound as the word the examiner provides (e.g., “Which word starts with the same sound as pig? Pan, cat, or dog?”)
The correct response is “pan.”). For the remaining 13 items, the examinee is asked to point to the picture that has the same final sound as the word the examiner provides.

d) Phoneme Isolation: The examinee is asked to identify the first and last sounds of words (e.g., “what is the first sound in the word mop?”). Subsequent items require the examinee to identify middle sounds and then to identify other parts of words made up of more sounds (e.g., “what is the third sound in the word stop?”). (Spoonerism: The task was first created by Landerl, Wimmer, and Frith (1997) “and required the exchange of the consonantal onsets of pairs of words. Participants are presented with two non-words and they are requested to switch two letters. e.g., In BOOT–VIS subjects are be asked to switch B with V, with the correct response being VOOT–BIS)” (De Jong & van der Leij, 2003, p.27). Ten items comprise the test. Half of the items included one consonant as an initial sound while the rest started with a consonant cluster. Another version of the spoonerism task is described in van den Boer, van Bergen & de Jong, where the instruction are the same but the consonants are within the word and not in an initial position (e.g., ‘larspos’ switch ‘l’ and ‘p’) (2015, p.143). In both versions the assessment was based on the number of accurate responses.

2.1.2 Summary phonological awareness

Phonological awareness can be described as the ability to successfully match a symbol to its corresponding sound. It constitutes a vital ability in literacy development and when this domain is problematic the developmental course is disrupted. Numerous studies investigating the effect of phonological awareness on reading and writing skills have concluded that it is in fact a strong predictor of literacy. Tasks that are used to tap into this cognitive mechanism typically rely on sound manipulation in the form of phoneme deletion, detection or recognition.
2.2 What is Visual Attention Span (VAS)?

According to Bosse, Tainturier and Valdois, the visual attention span (VAS) constitutes the number of visually aligned components that can be processed when these are presented simultaneously (2007). In other words, if someone is exposed to a letter or a digit string, his or her visual attention (VA) constitutes the number of units (i.e. letters or digits) that person will eventually be able to process. For instance, if a given person is confronted with the digit string 23465 and, upon prompted to do so, recalls 234, her visual attention span is 3. Findings from several studies have yielded results that support the hypothesis that dyslexia is the outcome of impairments in several cognitive functions, such as “processing multi-element strings”. In other words, VAS is now recognized as impaired in language developmental (notably related to literacy) disorders (Bosse et al., 2007, p.200).

Pinpointing the problem, what literacy impaired individuals appear to experience is a deficit in attention division among letters within a word. As a consequence, the total number of elements that can be processed while reading will be minimized (Bosse et al., 2007).

Considering the definition that has been given for VAS we can identify a connection with another cognitive function: working memory (WM) capacity. Working memory can be explained as a temporary storage of information for further processing including language-related information (e.g. reading or language comprehension) (Baddeley, 1992). According to Bleckley, Durso, Crutchfield, Engle & Khann, what lies at the heart of WM is an "attention-based executive" that employs a number of regulators (2003, p.884). These "buffers" are manifested in different ways when it comes to preserving information. Most important, one of their manifestations is a visual one, perhaps sharing many similarities with the VAS (p.884). Working memory capacity (WMC) plays a crucial role in the way an individual retains information. Bleckley et al. (2003) point out
that not everyone is able to recall and preserve information regardless of distractors in the same way and the difference lies in an attention mechanism. In order to execute a task one has to be capable of not only retrieving but also paying attention solely to "task-related" information (p.885). From this it can be inferred that WMC is connected to VA, since before focusing on the relevant information a person must first process it and then decide which aspects to focus on.

Bleckley et al. investigated whether WMC affects the distribution of VA and hypothesized that there would be variation in "the way high-WMC and low-WMC individuals allocate attention" (2003, p.885). They went on to speculate that participants with high-WMC would show the capacity to focus on the "areas of the visual field" that are essential for a task and will not be distracted by "other areas" (p.885). On the other hand, a person with low WMC was hypothesized to have problems in "allocating attention flexibly" (p.855). To that end Bleckley et al. designed an experiment testing WMC and VA allocation. WMC was tested using an operation–word-span task (OSPAN), where subjects are requested to characterize mathematical operations as correct or not and at the same time memorize several words (exemplified in “Is (2 3 3) + 1 = 4? aunt” (p.886)). After finishing a set subjects were asked to write down the words they were able to remember. On the basis of the OSPAN outcomes, 20 participants were recruited to take part in the VA allocation task: 10 with the highest and 10 with lowest scores. As part of the VA allocation task subjects were asked to recognize a letter presented “briefly at the centre of fixation and to locate a letter presented on one of three concentric octagons, spaced at intervals of 1° visual angle” (p.886). Combinations of one letter located at a central position and one placed “at one of the 24 locations of the octagons” comprised the stimuli. The letters were one of the following, C, O, Q, F, L, T, V, X, and Y. The researchers expected subjects that exhibited high-WMC to outperform their peers in terms
of attention distribution. Conversely, they expected individuals with low-WMC to be less able to focus on the required stimuli and ignore any distracting elements in the process. Their hypothesis was confirmed by the outcome of the experiment, which revealed that high-WMC indeed positively affected the allocation of attention. As the researchers stated, participants with a high WM span “were able to allocate their attention to discontinuous locations, the centre letter and the cued ring” (p.888).

At this point it would also be useful to include another cognitive ability related to VA and reading skills, and that is visual processing. Visual processing is essentially the ability to decode a visual stimulus. Even though - naturally - visual acuity is important in this, visual processing is more than just physically perceiving a visual stimulus: it is about how a person interprets what he or she sees, for example being able to distinguish between different geometrical shapes. This capability of being able to “identify what is seen” is typically seen as a prerequisite in learning to read (refs: ideally add one or several references here). Disruption in visual processing may lead to insufficient decoding of what is perceived through vision (e.g. inability to tell letters apart). This will consequently affect the number of elements that are being processed, a fact that may in turn affect VA. In other words, visual processing may be seen as a prerequisite for visual attention, and yet still being distinct from it.

2.2.1 VAS and reading development

Ans, Carbonnel and Valdois made the connection between VAS and the reading process by constructing their “MultiTrace Memory model of reading (MTM)” (1998, p.679). According to this model, the reading process depends, among other cognitive functions, on the “visual attentional window” which depicts the quantity of “orthographic
information” a person is able to process while reading (Valdois et al., 2014, p.122). Along with the VA, these two components – i.e. VAS and the visual attention window - delineate “the set of visual letters” that the reader can concentrate on (p.122). More specifically, the MTM model suggests that the reading process depends on two processes, the “global (parallel) and analytic (serial)” procedure (p.122). These procedures are different in terms of VA window size and consequently the VAS abilities they require. In the first global procedure attention is spread out to the entire letter string but in the latter analytic procedure, the focus is placed on a single element. From this it could be assumed that items that have been encountered before would be processed within the global mode and the analytic procedure would be employed to tackle unknown items (such as non-words).

During the course of reading development, word recognition progressively moves from single-letter to more complex-unit identification. Having said that, it could be expected that in order to identify and eventually retain larger orthographic units (e.g. syllables or complex morphemes), it is necessary that a person’s VAS has the capacity to accommodate all the presented information. Based on this conclusion the authors speculate that whole-word processing would be the first to be affected by VAS deficits in developmental dyslexia. According to Valdois et al. (2014) deficiencies of that nature will severely disrupt the reading process; the speed of real word reading will be considerably reduced, while irregular word reading will be characterized not only by slow speed but also inaccuracy.

Primary school graders form a population that has been extensively studied to uncover the role of the VAS in the development of reading. Van den Boer et al. (2012), among others, emphasize the relation between primary school reading success and VAS capacity. In their article they maintain that VAS can constitute a contributor of reading success, independent of IQ and phonological skills. As related above, the VAS is the total number of letters that someone can “process in parallel”, so it is only logical that any tasks
designed for its assessment would measure exactly that (Van den Boer et al., 2012, p.245; Bosse et al., 2006). Still, it has been reported that reading performance can also correlated with the “parallel processing” of non-alphanumeric sequences such as "Hiragana, pseudo-letters, and unfamiliar shapes (Van den Boer et al., 2012; Lobier et al., 2011, p.3). Tasks designed for VAS assessment require participants to report a number of elements (letters, digits or non-alphanumeric stimuli), a process that resembles exercises that are employed to assess rapid naming and the VAS contribution to reading has been questioned (Van den Boer et al., 2012). It is a fact that in both rapid naming and VAS tasks, the participant is exposed to a letter string that they have to briefly report. However, there is a major difference in the underlying conditions of the two assessments (i.e. VAS and rapid naming), predominantly in the time of exposure to the stimulus. In VAS tasks the sequence is briefly displayed before it disappears, while in rapid naming it does not disappear (Van den Boer et al., 2012). Consequently, the two conditions tap into different constructs; the former examines the ability to attend to as many letters as possible at a glance while the latter assesses the speed and accuracy of letter recognition (Van den Boer et al., 2012).

2.2.2 VAS and language orthographic transparency

Phoneme-grapheme correspondence, i.e. language transparency, has been proven to be of pivotal importance in language acquisition and more specifically in the development of reading skills. One-to-one mapping of graphemes and their phonological representations is not a language universal characteristic; some languages are much more transparent than others. There seems to be a relationship between VAS and orthographic transparency. According to Valdois et al. (2014), a VAS deficit will be manifested differently in different languages as a function of orthographic units of various lengths. The main reason for this is claimed to be that longer, less transparent units pose problems
for VAS impaired individuals, who have difficulty with whole-word letter string parallel processing (p.122). An example in case is French, which is a language that is relatively opaque as far as grapheme to phoneme correspondence is concerned. In addition, it includes a number of multi-letter comprised units (Valdois et al., 2014). By means of example, in French, the written representation of a phoneme may enclose “two letters such as ou /u/ in pour (/puR/, for) but some others may have three letters (eau /o/, water) or even five, such as aient (/3/) in ils e’taient (/et3/, they were)” (Valdois et al., 2014, p.122). This means that grapheme-phoneme mapping requires processing several elements at the same time. In other words, learners of French who show a VAS-related impairment, will have a hard time coming to grips with their mother tongue once literacy starts to develop.

To further support the relation between language transparency and VAS, Valdois et al. (2014) provide a similar analysis as that for French, but this time for a more transparent language: Spanish. In Spanish a simple correspondence between graphemes and phonemes is sufficient in order to read the majority of words. More specifically, Valldois et al. mention that that this language “only has three two-letter graphemes: rr (perro= /perro/, dog); ch (pecho= /peʃo/, chest); ll (bello= /bejo/, beautiful) (Valdois et al., 2014). There furthermore is a limited number of letters (c, g, qu, gu) that require one to rely on the context in order to achieve correct pronunciation. Additionally, any uncertainty that may arise concerning how to correctly pronounce a word, requires the simultaneous process of solely “two or three letters (qu+ e or i (yields /ke/ or /ki/), gu+e or i (/ge/ or /gi/)” (Valdois, et.al., 2014, p.123). As a final remark, it is mentioned that the Spanish language does not include any irregular words, a fact that can facilitate the reading process. The researchers concluded that successful reading performance in Spanish can be attained
with a smaller VAS since there is no need for larger units to be processed. This is notably different from the VAS required for successful reading in French.

Consequently, regular and non-word reading would be less affected when a VAS deficit -which is translated as a limited capacity for simultaneous process- is present in a learner of Spanish compared to a learner of French. This argumentation can even be extended to claim that reading accuracy problems are more prevalent in French than in Spanish, which appears to be borne out of several investigations (Valdois et al., 2014).

2.2.3 Tasks used to assess VAS

As related above, VAS is subdivided into a global and partial ability, which also translated into two separate, yet complementary test procedures. The following tasks are typically employed to assess both functions separately.

*Bar Probe Tasks:*

1) *Partial report Bar probe task:* For this tasks participants are presented with a letter string consisting of 5 elements (e.g. T H F R D). In order to help the participants to focus on the screen a fixation mark on the screen typically precedes the presentation of the letter string (Lobier et al., 2011, p.770). After they have been exposed to the stimuli, subjects are expected, for every sequence, to recall and verbally report only one letter that was included in it.

2) *Global Report Task:* This task is designed in the same way as its partial report bar probe counterpart. The difference here is that the participants have to orally repeat the whole letter string (Lobier et al., 2011). The total number of letters they are able to report correctly comprised their score. It has to be noted that the order in which they are able to recall them is not important. What is measured is accurate identification.
2.2.4 Summary for VAS

Visual attention span is a cognitive ability that has to do with the total number of aligned letters one can attend to. Even though it is a recent addition to literacy contributors there is already ample evidence that it considerably influences the development of reading and writing skills. Studies have also showed that a limited VAS can be the cause of learning difficulties. What should not be dismissed is the fact that this skill appears to heavily rely on and correlate with other cognitive predictors, such as working memory, visual processing and rapid naming. The inevitable question then becomes whether VAS is even a unitary construct at all or whether it is more an umbrella term for processing capacity in individual learners.

2.3 Summary

When it comes to literacy development, several cognitive abilities have been related to its success, such as rapid naming, working memory, verbal short term and phonological awareness. Of these predictors, the ability to form sound-symbol correspondence has traditionally featured most prominently as an influential factor shaping the literacy trajectory. In other words, the relationship between phonological awareness and literacy has been investigated for decades and their correlation has been well established. Deficits in this cognitive ability have been held responsible for several language impairments such as developmental dyslexia, but also Specific Language Impairment (SLI) (Aravena et al., 2013; Rispens & Beeb, 2007). More recently, another cognitive skill has been posited as integral in acquiring literacy abilities: VAS, which constitutes the simultaneous process of visually aligned components.

The two contributors of phonological awareness and VAS are mostly kept distinctly separate. However, a link could still be forged between them: in phonological processing
one sees a letter and has to be able to trace its corresponding sound and, assuming that there is no deficiency in that domain this process will be successful. But what happens if a person is VAS impaired and is not able to attend to all aligned letters? Does this mean that since one cannot process all letters they will not be able proceed to the next step and successfully assign all symbols to their corresponding sounds?

The emergence of the VAS hypothesis as a literacy contributor has shifted the attention from phonological awareness. At the same time, VAS being a construct with a much shorter research tradition, it is as yet unclear to what extent VAS is a single construct or an umbrella term for several cognitive abilities related to processing. In short, there is now a need to revise the current state of the art of literacy skills. The current study will attempt to do so by presenting a metastudy of the most commonly cited and most recent studies that have looked at either construct and review their outcomes.
Chapter 3: Where are we; a metastudy of phonological awareness and VAS as predictors of literacy success

The main aim of this metastudy it to review as exhaustive a list as possible of studies that deal with the predictive values of the two constructs under consideration in relation to literacy success, separately. For both constructs the main criterion according to which the studies were selected was the year of publication. VAS has been recently explored in relation to literacy but phonological awareness has been investigated for decades. To include a similar timespan, only those phonological awareness studies of the last 13 years were included. Most recent studies incorporate findings from earlier work in their theoretical framework, thus creating an up-to-date account of phonological awareness. Age of the participants, language under investigation, research question as well as findings are the aspects of each study that will be assessed. Finally the contributions of both predictors will be discussed, and directions for future research will be identified.

3.1 State of the art: past work on phonological awareness and VAS as predictors of literacy success

Table 3.1 and 3.2. below detail those studies that have looked at the predictive value of phonological awareness and VAS respectively on literacy skills. The tables are organized on the basis of alphabetical order, based on first author surnames. The tables detail not only factual information such as the year of publication, but also list whether the study relates the constructs of phonological awareness and VAS respectively to reading or writing skills (or indeed both), the measures used to tap the constructs, and the language context. Of crucial importance is the summary of each study’s results that is presented in the tables.
Table 3.1 Studies investigating phonological awareness

Table 3.1 below first details the overview of studies looking at phonological awareness and its predictive value in literacy success. As the number of publications incorporating phonological awareness is vast, the list below includes recent literature that is limited to the last thirteen years.
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<thead>
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<th>Study</th>
<th>Relationship to reading and writing skills</th>
<th>Language</th>
<th>Participants</th>
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<tr>
<td>Aravena (2013)</td>
<td>Reading Dutch (L1)</td>
<td>Dyslexic: n= 62 Controls chronological age matched: n= 64 mean age= 9.79 (range 7.4 – 12.4)</td>
<td>The study included three training conditions: Associative, explicit and a combination of the two.</td>
<td>Dyslexic participants performed poorly in word reading tasks. Deficits in letter–speech sound associations are found to be the cause of dyslexia. Combining explicit and implicit instruction is more effective in the beginning of letter–sound matching learning than just implicit training.</td>
<td></td>
</tr>
</tbody>
</table>

Explicit instruction approach: systematic instruction of phonological structure and letter–speech sound mapping

Associative instruction approach: computer game for speech sounds to orthographic representations association.

Letter knowledge:
1) Error rate within computer game
2) Word reading rate in artificial orthography was measured with lab-created time-limited test (3MAST) comprised of a 30 high-frequent Dutch word list written with the new orthography.
3) Mastery of orthographic rule acquisition was measured with a 3MAST reading test.
4) Vocabulary was measured using a WISC-III subtest (Kort et al., 2005)
<table>
<thead>
<tr>
<th>Study</th>
<th>Language</th>
<th>Group Description</th>
<th>Tasks</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosse (2007)</td>
<td>French (L1)</td>
<td>Dyslexic and controls n=123</td>
<td>1) Reading: regular, exception and pseudoword reading&lt;br&gt;2) Phonological awareness:-- Phonemic segmentation&lt;br&gt;- Phoneme deletion&lt;br&gt;- Acronym task&lt;br&gt;3) VAS: Bar probe tasks: global and partial condition</td>
<td>Phonological as well as VAS capacities were responsible for the range of attested reading skills. Even after IQ, phonological awareness and verbal fluency were controlled, VAS was still a contributor to reading skills. Dyslexia more likely to result from VAS deficits than phonological awareness deficits.</td>
</tr>
<tr>
<td></td>
<td>English (L1)</td>
<td>Mean age: 11.6 (range 8.9-16.2)</td>
<td>British: dyslexic and controls n=52 mean age: 10.6 (range 9-11)</td>
<td></td>
</tr>
<tr>
<td>De Jong (2003)</td>
<td>Dutch (L1)</td>
<td>Dyslexic readers: n=19&lt;br&gt;Weak readers: n=17&lt;br&gt;Normal readers: n=19 mean age: 5.4 (range 5.1-6.1)</td>
<td>1) Reading and Reading-Related Knowledge:&lt;br&gt;- Letter knowledge.&lt;br&gt;- Word identification: Accuracy&lt;br&gt;- Word identification: speed.&lt;br&gt;- Reading comprehension&lt;br&gt;- Spelling test: PI dictee (Geelhoed &amp; Reitsma, 1999)&lt;br&gt;2) Phonological Awareness&lt;br&gt;- Categorization of rhyme, first sound, and last sound.&lt;br&gt;- Sound deletion and substitution.</td>
<td>Phonological skills were highly associated with word decoding but did not have an additional influence on the further development of word decoding after first grade. Dyslexia can result from phonological deficits.</td>
</tr>
<tr>
<td>Den Boer (2012)</td>
<td>Reading and spelling</td>
<td>Dutch (L1)</td>
<td>Typically developing</td>
<td></td>
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<td></td>
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<td></td>
<td>Study1:</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>2nd graders: n=117</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>mean age: 8</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>5th graders: n=111</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>mean age: 11</td>
<td></td>
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<tr>
<td>Study2:</td>
<td></td>
<td></td>
<td>4th graders: n=255</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>mean age: 9.11</td>
<td></td>
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</tbody>
</table>

- Spoonerisms

**Study1:**

1) Word reading fluency: one minute test

2) Vocabulary: RAKIT battery (Bleichrodt, Drenth, Zaal, & Resing, 1984)

3) Phonemic awareness: elision and spoonerism tasks

**Study2:**

1) Word reading fluency: one-minute test

Non-word reading fluency: Klepel

2) Orthographic knowledge: orthographic choice task

3) Spelling: PI dictee (Geelhoed & Reitsma, 1999)

4) Phonemic awareness: letter span task

Phonological awareness proved to be correlated to word reading in all grades and a "strong predictor" for non-word reading. It was also responsible for the variation attested in spelling capacities.
Dessemontet (2015) 

**Reading French (L1)**

- Intellectual disabilities (ID) of unspecified etiology: n=129
- Mean age: 7.8 (range 6.11-7.9)

1) Phonological awareness:
   - Rhyme detection (6 items)
   - Syllable fusion (6 items)
   - Syllable segmentation (7 items)
   - First phoneme fusion (5 items)
   - Phoneme fusion (8 items)
   - First phoneme detection (8 items)
   - Last phoneme detection (8 items)
   - Phoneme substitution (4 items)

2) Letter-sound naming subtest

3) Non-word and word reading tasks

4) Reading Comprehension:
   - Word comprehension
   - Sentence comprehension
   - Instruction comprehension
   - Text comprehension

Phonological awareness and letter-sound knowledge are predictors of progress in reading skills in children with ID with unspecified etiology.
### Measures of phoneme awareness were the best concurrent and longitudinal predictors of reading skills

**Hulme (2002)**  Reading  English (L1)

**Poor readers:** n= 36

Typically developing readers: n= 36

mean age: 5.6 (range 5.14- 6.34)

- 1) Phonological awareness:
  - Deletion task
  - Oddity task
  - Detection task

- 2) Reading skills:
  - British Ability Scale-II single-word reading test
  - Receptive vocabulary was assessed by the British Picture Vocabulary Scale (2nd Edition)

**Rispens (2007)**  Reading  Dutch (L1)

**SLI:** n=11

**Dyslexic:** n=17

Typically developing age matched: n=17

mean age: 13.07 (range: 9-19)

- 1) Phonological awareness:
  - Phonological
  - Non-word repetition

- Subject verb agreement

Developmental dyslexia does not exhibit only literacy or phonological problems, but also morphosyntactic deficits.
<p>| Ritter (2013) | Reading English (L1) | Language impaired: n= 75 mean age: 6.05 (range: 5.7- 6.4) | Phonological training intervention 1) Letter identification, reading real words and non-words, as and reading comprehension: - Letter-Word Identification - Word Attack (Woodcock, 1997) - Passage Comprehension 2) Phonological awareness: - Comprehensive Test of Phonological Processing (CTOPP) - Blending Words subtests | Phonological Based Intervention positively influences phonological awareness skills and hence improves reading skills |
| Talwar (2009) | Spelling English (L1, L2) | No known diagnosis: 85% Known diagnosis: 11.7% Unsure about diagnosis:3.3% mean age: 28.57 (range: 16-59) | 1) Two dictated spelling tasks 2) Phonological Awareness: -Word Attack subtest of the Woodcock Reading Mastery Tests (1997).A phonetic decoding of non-word task. - Phoneme Recognition Task | Phonological awareness was - on a whole - found to be a predictor for spelling skills |</p>
<table>
<thead>
<tr>
<th>Warmington (2011) Reading English (L1)</th>
<th>Typically developing: n= 79 mean age: 9.10 (range 7.8 - 11.10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Phoneme Elision subtest of the Comprehensive Test of Phonological Processing (CTOPP)</td>
<td></td>
</tr>
<tr>
<td>1) Single word reading: The Wechsler Objective reading Dimensions</td>
<td></td>
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<tr>
<td>2) Regular and irregular word reading</td>
<td></td>
</tr>
<tr>
<td>3) Nonword reading</td>
<td></td>
</tr>
<tr>
<td>4) Reading fluency: Test of Word Reading Efficiency (TOWRE, Torgesen, Wagner, &amp; Rashotte, 1999)</td>
<td></td>
</tr>
<tr>
<td>5) Phoneme deletion task</td>
<td></td>
</tr>
</tbody>
</table>

Phoneme awareness was a predictor for non-word reading

Table 3.1 Studies investigating phonological awareness
3.1.1 Main trends:

Based on the selection criterion of limiting the meta-study in the past 13 years a total of 10 studies that investigate the role of phonological awareness to literacy development were included in the table. By looking at the phonological awareness table some main trends can be deduced. The main aim of the studies included was to determine whether phonological awareness can predict and contribute to the development of literacy skills. Additionally the relationship that exist between deficits in this domain and the emergence of language difficulties has also been examined. However, all of the studies under investigation focused on the effect of this construct to reading skills while writing development was glaringly ignored, creating the need for further research that the contribution of the Dutch contingent in this line of work has been considerably, evidenced from Dutch being the dominant language under investigation. This may be due to the fact that Dutch is considered an orthographically transparent language, facilitating the testing process.

Furthermore we can see that the age range of the learners under investigation varied, but almost always targeted primary school children. Within these studies the attention seems to be placed on one of two categories: those looking at the precursors of literacy, by looking at children around 5 to 6 years old, right before literacy training begins. The other category consists of kids right in the middle of their literacy development, but extending all the way up to the end of primary education (ages ranged between 7 and 12 years old). Only one study was found that targeted adults i.e. it included participants with a mean age of 28.6 years old (ages ranged from 16 to 56 years old) (Germano, Reilhac, Capellini & Valdois, 2014). But indeed, the adult as well as adolescent population has been heavily under-researched. The majority of the studies included have targeted participants
that suffered from a language impairment or SLI (Aravena et al., 2013; Jong & van der Leij, 2003; Dessemontet & de Chambie, 2015; Hulme et al., 2002; Rispens & Been, 2007; Ritter, Park, Saxon & Colson, 2013). However, what it is evident from the participants’ description in the studies, is that typically developing participants included in these experiments were matched based on age and not on development.

As far as the assessment is concerned it is evident from the table that there is a wide range of tasks that have been employed but still we can detect some tendencies. Phoneme deletion, detection and recognition appear within the majority of studies as a means of phonological awareness assessment (see section 2.1.1 for task description). All three tasks target the participants’ ability to recognize and manipulate the various sounds of a language.

Finally, going through the results of each experiment we can see that there seem to be no discrepancies among the produced results. Diagnostic studies have determined that phonological awareness is indeed a reliable and independent predictor of the development of reading and spelling. Moreover, experiments that investigated impaired learners reached the conclusion that abilities related to phonological awareness and more specifically any related deficits are the cause of learning difficulties. In all experiments subjects that exhibited a language deficit (defined as an underlying phonological awareness problem) were outperformed by the control groups in reading and spelling tasks. Studies that included interventions on phonological awareness further supported its importance in successful literacy development. Participants that received phonological based training were able to improve their ability to form symbol-sound correspondences, which in turn had a positive effect on their reading skills (Ritter et al., 2013). Additionally, the study conducted by Aravena et al. (2013) provided an insight into the instructional approach that would be (most) appropriate for letter-sound mapping training. Based on the finding of
this experiment, in the early stages of acquiring these correspondences a combination of implicit and explicit instruction would be the optimal approach.

**Table 3.2 Studies investigating VAS**

Table 3.2 below moves away from phonological awareness and focuses instead on studies looking at the contribution of VAS on literacy development, but follows the same structure as Table 3.1 In total six studies were employed to build up the table on VAS literature. Given the fact that VAS has only been associated with literacy relatively recently, the present list is limited to the studies created within the last decade.
<table>
<thead>
<tr>
<th>Study</th>
<th>Relationship to reading and spelling skills</th>
<th>Language</th>
<th>Participants</th>
<th>Measures/ tasks</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosse (2007)</td>
<td>Reading</td>
<td>French (L1) English (L1)</td>
<td>French: dyslexic and control n=123 mean age: 11.6 (range 8.9-16.2)</td>
<td>1) Reading: regular, exception and pseudoword reading</td>
<td>Phonological as well as VAS capacities were responsible for variance in reading skills. Even after IQ, phonological awareness and verbal fluency were controlled, VAS was still a contributor to reading skills. Dyslexia may result from VAS deficits</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>British: dyslexic and control n=52 mean age: 10.6 (range 9-11).</td>
<td>2) Phonological awareness - Phonemic segmentation - Phoneme deletion - Acronym-task</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3) VAS: Bar probe tasks: global and partial condition</td>
<td></td>
</tr>
<tr>
<td>Bosse (2014)</td>
<td>Reading and copying</td>
<td>French (L1)</td>
<td>Typically developing: n=75 Mean age 3rd graders: 8 5th graders: 11</td>
<td>1) Copying task and gaze lift recording</td>
<td>VAS was involved in both reading and copying.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2) Reading task and eye movement recordings</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3) VAS assessment: global and partial report tasks</td>
<td></td>
</tr>
<tr>
<td>Den Boer (2015)</td>
<td>Study 1:</td>
<td>Dutch (L1)</td>
<td>Typically developing</td>
<td>Study 1: 1) Word reading fluency: one minute test</td>
<td>VAS was a unique predictor of both spelling and orthographic performance and a contributor to reading skills. Phonological awareness was an equal predictor of both skills</td>
</tr>
</tbody>
</table>
### Study 2: Spelling

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Sample Size</th>
<th>Mean Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd graders</td>
<td>n=117</td>
<td>8</td>
</tr>
<tr>
<td>5th graders</td>
<td>n=111</td>
<td>11</td>
</tr>
<tr>
<td>4th graders</td>
<td>n=255</td>
<td>9.11</td>
</tr>
</tbody>
</table>

**Reading (VAS as an independent predictor)**

- 2nd graders: n=117, mean age: 8
- 5th graders: n=111, mean age: 11

**Study 2:**

1. **Word reading fluency:** one-minute test
2. **Non-word reading fluency:** Klepel
3. **Orthographic knowledge:** orthographic choice task
4. **Spelling:** PI Dictee (Geelhoed & Reitsma, 1999)
5. **Phonemic awareness:** letter span task
6. **VAS:** whole report task

**Study 2:**

1. **Vocabulary:** RAKiT battery
2. **Phonemic awareness:** elision and spoonerism tasks
3. **VAS:** global report task
<table>
<thead>
<tr>
<th>Study</th>
<th>Language (L1)</th>
<th>Sample Description</th>
<th>Tasks</th>
<th>Findings</th>
</tr>
</thead>
</table>
| Germano (2014)| Brazilian Portuguese | Dyslexic: n=33, Control: n=33 | mean age: 10.2  
1) Text reading task  
2) Phonological skills:  
   - Phoneme identification (PhoId)  
   - Syllable blending (SyBl)  
   - Phoneme blending (PhoBl)  
3) Visual processing:  
   - Visual form constancy subtest (VFC)  
   - Visual closure subtest (VC)  
   - Letter global report task (LGR) | Visual processing abilities affected reading fluency significantly and independently |
| Lobier (2011) | French (L1)   | Typically developing: n=119, Dyslexic: n=14 | mean age: 8.8  
1) VAS assessment: five-consonant global report task  
2) Reading assessment: isolated and pseudo-word reading  
3) Categorization task. Verbal and non verbal stimuli | Evidence that the VAS deficit in dyslexia is visual and not verbal |
<table>
<thead>
<tr>
<th>Valdois (2014) Reading</th>
<th>Spanish (L1)</th>
<th>French (L2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyslexic: n=1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>age: 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typically developing: n=9</td>
<td></td>
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<tr>
<td>mean age: 7.11</td>
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</table>

**Intervention Study**

1) Reading performance French: ODEDYS battery for regular, irregular pseudo-word reading.

Spanish: PROLEC battery for real and pseudo-words.

Reading fluency and accuracy: text reading in both languages.

2) Phonological assessment: phoneme deletion, phoneme segmentation and acronym tasks (in L1 and L2).

3) VAS assessment: two global and partial report tasks.

The VAS intervention led to an increase of the components the subject could process (i.e., the span). This resulted in an improvement of the reading procedure, highlighting its importance to successful reading acquisition.
3.1.2. Main Trends:

Unlike phonological awareness the VAS as a literacy contributor is a recent construct, which is evident from the studies and their year of publication) that investigated this relationship. One significant difference that emerges from a comparison of the two tables is that the VAS literature is not restricted to the examination of the VAS influence on reading but also on spelling skills. As can be seen from the table, one study even investigated the effect of VAS on copying skills, a correlation that was entirely absent from the phonological awareness literature. Additionally, based on the available literature - it is evident that VAS studies often appear to include a phonological awareness measure, which vice versa was not the case. However, the most likely explanation for this trend lies in the fact that VAS is a relatively recent addition to this research tradition.

As far as age of the learner is concerned, there is a rather larger range in VAS studies (8 to 14 years old). In other words, the VAS studies appear to move slightly beyond the primary schools years, but, similarly to phonological awareness, the adult population is absent from the list. The dyslexic population again seems to be preferred as a target population, with more than half of the experiments investigating language impaired subjects, Moreover, in studies that included reading impaired participants, as in phonological awareness, the typically developing controls were age-matched. Lobier et al. (2011) seemed to have followed another direction and matched their groups according to reading ability rather than chorological age. This is also witnessed through the mean ages of the groups, where the typically developing subjects have a mean of 8.8 while the dyslexic group has a mean age of 10.7 years.
Furthermore, it is evident that there is a variety in languages under examination, something that was missing from the phonological awareness list. We could say that the VAS studies cover a wide range in terms of orthographic transparency (from French, an orthographically opaque language to the transparent Brazilian Portuguese), providing an exhaustive literature on the relation between VAS and orthographic transparency.

Global as well as partial report tasks are employed from the majority of the studies in order to assess VAS abilities. The one exception to this trend is Germano et al., (2014), where two more task was added, namely a Visual form constancy subtest (VFC) and a Visual closure subtest (VC).

When it comes to results there is a consistency in the way VAS was found to influence literacy skills. The theory that VAS is a significant predictor for literacy skills (reading and writing) was corroborated by all studies. It accounted for significant variance in reading and writing performance independently from other cognitive abilities such as phonological awareness and rapid naming. An interesting finding was reported by Valdois et al., (2014), who reported a case of a dyslexic participant who exhibited a VAS impairment but no phonological skills deficits.

3.2 The contribution of phonological awareness and VAS to literacy development

During the past decade a considerable amount of research has been published with the aim of investigating whether and how phonological awareness and VAS can affect the course of reading and spelling skills development. The majority of the conducted experiments that targeted the VAS included measures for both contributors in order to determine if there is a correlation between the two (Bosse et al., 2007; Bosse, Kandel, Prado & Valdois, 2014; Germano et al., 2014; van den Boer, van Bergen & de Jong, 2015). In the following section the results of the studies under consideration will be discussed in
more detail and separately for each construct. Section 3.2.3 then compares and contrasts the findings of both constructs to see which is more powerful in explaining literacy success.

3.2.1 The contribution of phonological awareness to literacy development.

In 2003, de Jong & van der Leij created a longitudinal study with the purpose of examining how phonological impairments progress during the six years of Dutch primary school. The population sample included dyslexic, normal and weak readers that exhibited phonological deficits and their development was examined from kindergarten to the 6th grade on three occasions (kindergarten, 1st and 6th grade). Apart from phonological awareness tasks a number of other measures were taken into account, such as non-verbal intelligence, linguistic comprehension, reading, spelling and rapid naming. Participant were tested individually, apart from the reading comprehension measure, which was an in-class test.

When reporting the results of the experiment the researches started by stating the outcome of the kindergarten testing. In terms of linguistic comprehension the three groups (dyslexic, weak and TD readers) did not perform significantly differently. On the other hand, the TD children outperformed the other two groups in rhyme categorization and rapid naming tasks.

Most importantly, in terms of phonological awareness, the dyslexic participants were not able to outperform the TD readers group in the “first and last sound categorization tasks”, while no differences were detected on rhyme categorization task (p.30). Rapid naming also proved to be a challenge for the dyslexic group, as they performed poorly compared to TD readers. Moreover, the researchers stated that in the beginning of 1st grade there was significant difference in “word-reading accuracy”
between these two groups as well as in non-word reading with the dyslexic group being outperformed by the TD (p.30). Reading speed of word and non-words then considerably increased, but only for the TD readers by the end of 1st grade. In addition, the TD readers showed leaps in their reading comprehension, which their dyslexic peers did not show. Finally, as weak and dyslexic children are concerned the only correlation that was found was that the former group performed better in number naming than the latter group. What may be considered an especially noteworthy finding is that the first year of reading instruction resulted - for the dyslexic group - in the elimination of deficiencies in “rhyme awareness”, which were detected in preschool years (p.33). Moreover, it was stated that deficiencies in dyslexic students “at the level of phonemes” appeared only after receiving reading instruction and in 6th grade phonological impairments were no longer detected (p.33). The attested results lend further support to the idea that phoneme and rhyme awareness are two different things and it is the former rather than the latter that influences the reading process. This renders rhyme awareness as a poor predictor of reading development, yet placing phonological awareness at the center of literacy development. This outcome is important as rhyme awareness is mostly considered a subdomain of phonological awareness. This differential finding suggests that phonological awareness may not be the simple, univariate construct that past studies have often assumed it to be.

The present experiment supported the concept that dyslexia is the result of phonological deficits (de Jong & van der Leij, 2003, p.36). Letter-sound correspondence deficits were detected in the dyslexic population in the initial stages of reading development. As a final remark the researchers expressed their reservations about the validity of the spoonerism task. They argued that it targets “onset and rhyme” awareness but not “on a phoneme level”, thus giving rise to the question of whether the dyslexic
group preserved “phoneme segmentation” deficits during all primary school years (de Jong & van der Leij, 2003, p.34).

The influence of awareness at the phoneme level rather than at the level of onset-rhyme in reading development was also investigated by Hulme et al., (2002). The subjects targeted in that study were at an initial stage of learning to read and were assessed in terms of phonological awareness. The longitudinal study that followed corroborated the outcome of the study conducted by de Jong & van der Leij (2003): Measures that assess the ability to make successful letter-sound correspondences proved to be “excellent simultaneous and longitudinal predictors of early reading skills” (Hulme et al., p.19). On the other hand, “measures of onset–rime awareness” were not found to be strong predictors of the reading process (p.19). Furthermore, “once shared variance with measures of phoneme awareness is accounted for”, these measures do not offer any contribution in explaining “individual differences in reading ability” (p.19). The implications that arise from this outcome, as presented by Hulme et al., (2002) are as follows. First of all, identifying the ability that contributes the most to reading development helps creating a more effective test battery to detect reading deficits. Tasks that evaluate phoneme awareness can be considered more reliable than onset-rhyme tasks when investigating reading development. When analyzing the results the researchers noticed some “internal consistency or reliability” dissimilarities among the employed tasks (p.19). Oddity and detection tasks did not exhibit as high an internal reliability as the deletion tasks, leading to the assumption that the latter would be more suitable to assess phonological awareness in the initial stages of reading development.

Another implication following from Hulme et al’s (2002) investigation pertains to instructional approaches. They suggested that since there is proof that it is “phoneme
level skills” that influence the course of reading development, one would assume that when dealing with weak readers the best way to assist them would be to engage them in “phoneme-level training” (p.20). Even though phoneme related abilities are essential in literacy development, according to Hulme et al., (2002) focusing only on symbol-sound mapping may not constitute the best solution. They argue that there is a certain sequence that children follow in “phonological development” and that is first identify larger units and then move on to the awareness of their comprising units (i.e. phonemes) (p.20). The fact that in their experiment the participant found it more challenging to recognize phonemes than large units (onset-rime units) provides additional support for their argument.

Whereas the studies detailed above are mainly examinations of the effective contribution of phonological awareness on reading success, intervention studies also exist. In 2013, Ritter et al. examined the construct of phonological awareness and especially the effect of intervention aimed at improving phonological awareness in a language impaired population. They suggested that a phonological awareness intervention (PAI) would greatly benefit students with poor reading abilities. The subjects that participated in this study received “systematic PAI integrated with sound-symbol correspondence using a narrative platform for two, 15-min sessions per week for a total of 12 weeks in a small-group setting fosters PA, word-level reading, and passage comprehension skill development” (p.374). The outcome of the study confirmed the researchers' hypothesis. Students that were engaged in PAI were able to score higher that the control group when assessed on certain “subtests of phonological awareness skills (blending words and non-words)” (p.374). When testing for reading comprehension only the PAI group demonstrated significant progress before and after the intervention. Based on that finding Ritter et al. (2013) suggest that students with language impairments are able to improve
their reading skills as well as their phonological awareness skills, two crucial aspects for developing literacy skills.

Letter-sound mapping intervention and its influence on reading development was also examined by Aravena et al. (2014). In their experiment they employed a group of dyslexic and typically developing participants with the purpose of teaching them “eight basic letter-speech sound” combinations of an “artificial orthography” (p.694). The orthography was characterized as artificial because the participants’ mother tongue (Dutch) was represented with Hebrew characters. By introducing them to novel letter-sound correspondences they wanted to detect differences in the way their two groups acquired a “novel script” (p.694). Since dyslexia has been characterized as a phonological deficit they expected the control group to face fewer difficulties in the process. As an additional goal the researchers wanted to assess the effectiveness of the instructional approach and to that end they created three instructional conditions: explicit, implicit and combined (implicit and explicit) training. Both groups (the dyslexic and the TD) received a one hour training divided in thirty minutes sessions of implicit or explicit learning. The results of a series of four letter knowledge tests revealed that the dyslexic subjects did not differ from their non-impaired peers in the acquisition of the novel combinations. However, when the dyslexic participants were asked to put that knowledge into practice and engage in more difficult tasks they exhibited a “disrupted letter-sound speech deficit”, reinforcing the theory that the cause of dyslexia is a phonological impairment (p.702). The researchers also noticed that in letter-sound matching tasks that included time limitations the dyslexic participants tended to make more mistakes when compared to non-timed tasks. Additionally, the dyslexic group performed poorly compared to the typically developing group on reading tasks that included items written in the novel orthography. This outcome – which is in line with that of previous studies – once again highlights the importance of
phonological awareness in the development of reading skills. As far as the teaching methods are concerned (implicit and explicit or combined) the researchers reported that the combined approach was proven to be more effective for both the dyslexic and the TD participants.

To further explore whether there is a correlation between reading and phonological awareness, Dessemontet and de Chambrier (2015) conducted a longitudinal study in a population of intellectually challenged subjects. The researchers, based on previously conducted research, speculated that since phonological awareness and sound-symbol association can be reliable predictors of literacy progress in normal readers, this would also play a definitive role in the literacy development of their impaired sample. To that end they recruited a sample of 129 Swiss children between the ages of 6 and 8, all of whom exhibited intellectual impairments whose cause has not been determined along with other disorders such as ADHD or personality disorders. The subjects - apart from the initial assessment - were longitudinally tested one and two years following the initial assessment, to determine whether phonological awareness along with the ability to match symbols to sounds can function as predictors for development in “non-word and word reading and reading comprehension” (p.3). The test battery comprised four subtests that were conducted in both German and French. Phonological awareness was measured through “nine phonological awareness tasks” (see table 3.1).

As was anticipated by the researchers, after two years of instructions the participants significantly progressed in all four assessment subtests when compared to the first testing. In detail, the results from “non-word and word reading, phonological awareness and letter-sound knowledge” tasks from the initial and the second (after one year) assessment were found to be strongly correlated (p.7). Phonological awareness was
indicated to be the most influential factor in the development of word and non-word reading. Similar results were produced from the comparison of the first year and the third testing after two school years. The only difference was that this time it was the symbol-sound awareness from test 1 that accounted for the most substantial progress in word and non-word reading. The outcome of this study supports the notion that ability to match a letter to its corresponding sound is a reliable predictors of literacy progress. In general, these findings were in line with previous research on the importance of phonological awareness in the acquisition of reading skills among children that do not exhibit any language or intelligence deficiencies.

As it is clear that phonological awareness greatly contributed to reading success, some investigations have attempted to directly relate its contribution to that of other cognitive constructs, such as rapid automatized naming (RAN) and paired associate learning (PAL) (Warmington and Hulme, 2011, p.45). All three skills were found to be independent predictors since they influenced “different aspects of reading skills” (p.57). In more details, the experiment revealed that reading skills, most notably reading fluency, were highly correlated with RAN. Non-word reading was correlated with phoneme deletion. Interestingly, however, phonological awareness did not seem to affect “word reading, reading accuracy and reading speed”, aspects to which PAL and RAN were independent contributors (p.56). These findings provide a different perspective, indicating that phonological awareness may not always be the primary predictor of reading success.

The reviewed studies overwhelmingly focused on reading success to the detriment of writing abilities. The one exception is the study examining the contributors to spelling skills, designed by Talwar et al. (2009). They recruited a large adult sample population with low literacy skills with the purpose of examining if “phonological,
orthographic and morphological skills” can function as predictors for spelling skills (p.35). Irregular word reading as well as phonological awareness were found to be significantly correlated to spelling performance, proving that learning how to spell depends on both “phonological and orthographic information” (p. 44). Additionally, according to the results the more morphologically complex an item was the more difficult spelling was for the participants. Even though this may be attributed to “word frequency”, the researchers pointed at previous studies have reported that adults more easily read “frequency-matched simple” than “morphologically complex” items (p.44). As a result, it can be assumed that when a word consists of multiple morphemes its successful spelling depends on more advanced linguistic knowledge. This advanced linguistic knowledge in turn appears to be a contributor to spelling in children but here surfaces more as the mastery of symbol-sound correspondence. According to Talwar et al. adult spellers tend to employ their "phonological processing" abilities and this is the reason that “in error analysis studies, the most commonly made error type for adult learners was phonetic errors” (2009, p.44). Consequently, even though there may be substantial differences in phonological skills among children and adults, it is evident, according to the researchers, that spelling in the adult population still heavily relies on phonological abilities.

A completely different study was designed by Rispens and Been, who looked into the “subject–verb agreement and phonological processing in developmental dyslexia and specific language impairment (SLI)”, both of which were set off against a typically developing baseline group (2007, p.293). Since the purpose of the present study is to provide a detailed description of the construct of phonological awareness construct we will focus on the results that are related to that. The outcome of the study revealed the following differences in terms of phonological awareness among the three groups under investigation: deficits in the phonological domain were manifested differently in the
dyslexic and the SLI group. Both groups were outperformed by the control group in phoneme deletion tasks. However, there were also notably differences between the two impaired groups: the dyslexic group exhibited difficulties when they were requested to delete a phoneme in the initial position while the SLI group performed more poorly in “deleting consonants in word-final position” (p.302). In some cases the participants were not able to delete a phoneme at all, evidenced in both groups. The researchers attempted to provide an explanation as to why the dyslexic and normal readers found it hard to omit initial consonants. They argued that this results from a “strong preference for a filled onset position” (p.302). The most common syllable structure is the CV while “there are no languages that allow the VC structure” (p.302). This means that a reader is inclined to preserve an element in an onset position and finds it easier to omit a final component. From that it can be inferred that the difficulty that dyslexic subjects faced in deleting consonants in initial position is justified while the SLI difficulty for final position consonants seemed “unexpected” (p.302. This surprising difference among the two groups can lead to an interesting assumption that has not been observed so far; phonological awareness is not similarly manifested to all language impairments. A Phonological deficit does appear to underlie most language impairments; however, the way this is exhibited may vary according to the impairment.

3.2.1.1 Summary of phonological awareness literature.

Phonological awareness has been characterized by all studies as a strong literacy contributor. All the experiments included in the present metastudy yielded similar results that place phonological awareness on the top of the literacy contributors list (attaching more importance to it than other constructs such as rapid naming, verbal short term memory etc). Reading skills -especially non-word reading- that have been extensively
studied have been found to be significantly correlated with phonological awareness. The fact that pseudoword reading has been correlated with phonological awareness is interesting to uncover what mechanism readers rely on when encountering an unknown item. Readers, especially during the early stages of reading development, encounter a number of unknown words that they have to tackle. When the phonological domain is intact they will overcome this obstacle, building up towards successful reading development. Additionally, based on the studies considered so far, phonological awareness has been unanimously characterized as the cause of learning disabilities. One of the most important things that need to be taken into consideration is the finding by de Jong and van der Leij (2003) who found that rhyme awareness may constitute a separate construct. This finding cast serious doubts whether rhyme tasks should be employed as measures for phonological awareness. Finally, as was already pointed out, two things are largely missing in previous investigations and in order to uncover more about the construct of phonological awareness it would be good for future studies to take the following into account: expand the age group under investigation and further explore the correlation between phonological awareness and writing skills.

### 3.2.2 The contribution of VAS to literacy development.

When closely examining the contribution of VAS to literacy development, the list of studies are far less vast than those looking at the role of phonological awareness, and the studies are more recent. In 2011, Lobier et al. conducted a study with the purpose of exploring whether it is “a phonological coding deficit or a parallel visual processing problem” that is the origin of the VAS impairment in dyslexia (p.769). As a secondary aim of their study, they attempted to determine if the VAS deficiency in dyslexia is constrained only by verbal stimulation (Lobier et al., 2011). In order to do so they recruited two groups
of typically developing and dyslexic VA span impaired readers which tested in terms of reading performance, VA span and categorization tasks. The categorization tasks were consisted of “five different character categories: two verbal (letters and digits) and three non-verbal, (Hiragana, pseudo-letters and unfamiliar shapes) (p.771). In a “single categorization task: the participants were requested to identify in which category the presented stimulus belonged to by clicking on the correspondent label (p.771). The “multi element categorization task” included counting the characters that comprised the visually presented array (p.771). The results of the experiment revealed that the typically developing readers outperformed the group of dyslexic participants, proving that insufficient performance on all tasks is correlated to low scores in categorization tasks, “regardless of the stimuli” (p.772). This outcome led the researchers to conclude that the VA span has in fact a visual origin (p.772). As for the second research question, the results indicated that the participants with dyslexia performed poorly not only on alphanumeric tasks but equally bad in “non-verbal target categories”. This outcome strongly contrasts with the prevailing idea that dyslexia is the result of a phonological deficiency, thus confirming the impaired visual processing hypothesis (Lobier et al., 2011).

In line with the multi-factorial perspective of dyslexia was a study conducted by Bosse et al. (2007), whose aim was to prove that a VA span rather than a phonological deficit is the underlying cause of the language developmental disorders, most notably dyslexia. To that end, they created two experiments using two large groups of French and British participants. Their assessment battery “included three reading tasks, three metaphonological tasks and two visual attentional processing tasks” (Bosse et.al., 2007, p.203). The reading tasks consisted of two word lists of different frequency words and one pseudo-word list, which participants (French and British participants had a mean age of 11.6 and 10.6 years old respectively) were requested to read aloud “as accurately and fast
as possible” (p.203). The assessment of phonological awareness included the following exercises: a phonemic segmentation task, in which the subjects heard a number of words that they were later prompted to break down into their phonemic components; a “phoneme deletion task”, where they had to omit the initial sound of a word thus effectively creating a novel word; and an “acronym task”, where the participants were asked to create a new word by using the initial sounds of three lexical items they were exposed to (Bosse et al., 2007, p.203). Two “bar probe tasks” and a “partial report task” were used to assess the VAS (for task description see section 2.2.3).

As anticipated, the control group outperformed the group of dyslexic learners on all tasks apart from one phonological awareness task. The analysis revealed that task results for all three measures (reading, phonological awareness and visual attention span) were strongly correlated for both groups. Furthermore, significant correlations between the outcome of all reading tasks and the VA and phonological measures were reported, as well as among “some phonological measures and some VA measures”, albeit that the latter relations were found to be weak (p.207). To explore in greater detail the concurrence of cognitive abilities that affect literacy, three factors were extracted from the data: the VA, phonological and age factor, but this time the analysis was focused only on the dyslexic group (p.207). When chronological age was controlled, researchers reported that the VA and phonological awareness accounted for substantial variance in reading tasks, rendering both as influential variables in “reading accuracy” in the specific group of dyslexic learners (p.209). However, an important difference was found as well between phonological awareness and VA: VA processing skills proved to be an independent factor that accounted for equal variability in “exception and pseudo-word reading” tasks, while phonological awareness was responsible for variance only in pseudo-word reading, proving that “analytical reading skills” are more governed by phonological processing (p.210).
According to the researchers, the most important outcome of their study was not the phonological deficit that some subjects exhibited, which had already been confirmed by previous studies, but the “selective VA span deficit” that can support the hypothesis that dyslexia can be an impairment resulting from deficits in independent cognitive skills (p.210). For the second experiment they employed a group of 29 British dyslexic and a control of 23 participants, also British. The subjects from both groups had English as their native language and their ages ranged from 9 to 11 years old. As a first part of this experiment the researchers assessed the children's reading skills by using three reading tasks: “regular, exception and pseudo word reading” (p.212). Each of the tasks consisted of a word list that included 20 items, all similar in terms of frequency. Additionally, the words on all three lists were equal in number of syllables they contained as well as number of. A global report task, the same as the one used in the aforementioned experiment was used to measure visual attention. A number of other cognitive abilities such as phonological awareness, “access to receptive vocabulary, semantic fluency and letter identification skills” were also controlled, to explore in greater detail the extent to which VA affects reading performance (p.212). As far as the results of the second study are concerned the researchers stated that they replicated the findings of the first experiment. The control group significantly outperformed the dyslexic participants. The results from phonological as well as VA processing tasks were correlated with measures of reading performance. Even though VA was found to be correlated with “reading scores” no strong correlations between VA processing and phonological awareness was detected (p.214). When the dyslexic group was more closely examined, the analysis produced the same result as the first experiment: a considerable number of dyslexic subjects exhibited “a visual attention span deficit in the absence of phonological difficulties” (p.218). Similarly to the
first experiment this finding further supports the theory that it is a VAS and not a phonological deficit that can cause dyslexia.

To prove the correlation that exists between a VAS impairment and successful reading acquisition, Valdois et al. (2013) created a case study of a 7 year old French-Spanish bilingual girl who suffered from dyslexia. With the aim of assessing her phonological, reading and VAS skills, the participant's performance on relevant tests was compared to the results of a controlled group. In general, the results indicated that the girl was impaired in terms of VAS while her phonological skills remained intact. Based on the outcome the second part of this study was a VAS intervention program that lasted for 5 weeks. Six days a week the participant performed tasks that followed a specific order; “from non-verbal material (drawings, shapes, symbols) to verbal material (letters) and from single to multiple element processes” (p.130). The researchers based this intervention on the fact that the performance of such activities tap into the ability to process a number of elements at the same time; this means that the participant would rely on her VAS skills and further develop these skills. This study is furthermore unique because is moves away from the behavioural paradigm employed in previous work; fMRI scans were acquired before and after the intervention to explore if there would be a difference in the brain regions that were activated.

The VA training yielded positive results. First of all, the pre and post-intervention fMRI brain imaging demonstrated that after the intervention brain regions that are associated with VA (i.e., the superior parietal lobes) showed an activation that had not previously been observed. By comparing the subject with non-impaired peers, the researchers furthermore observed that her reading skills in French had improved. Even though scores for irregular words remained low, regular word reading was faster, exhibiting no significant difference compared to the typically developing group. As for
Spanish, again there was a difference in reading performance. Before the training the subject scored lower on regular as well as pseudo-word reading in terms of both accuracy and speed. After the intervention the number of words she was able to read in 60 seconds was approximately the same as the number obtained by the control group. Overall, these findings provide ample evidence of the importance of the VAS in successful reading development.

The aforementioned studies have focused their investigation on opaque languages such as French and English. The study designed by den Boer et al. (2015), on the other hand, aimed to examine whether a correlation between VAS and spelling can also be found in languages with more transparent orthography, such as Dutch. In the initial stage of this investigation the researchers wanted to examine whether VAS can be a predictor of reading regardless of rapid naming speed (another cognitive factor typically associated with reading impairments). 117 second and 111 fifth graders were selected and their native language was Dutch. The mean ages of the groups were 8 and 11 years old respectively. To assess reading ability, a word reading fluency test was administered, the One Minute Test, which is widely employed in (primary) schools in the Netherlands “to measure reading achievement” (p.143). For this task the students were required to read aloud a word list of 116 lexical items and do so as fast as possible. They were scored based on the number of errors they made. Rapid naming was tested by means of the reading of digits that were presented to the participants. They had to identify and say aloud the digit and the time required to “name all digits, converted to the number of digits named per second” constituted their score (p.143). VAS was measured with a global report task. The outcome of the study proved VAS to be an independent predictor of reading ability. VAS was found to be a “significant unique predictor of word reading fluency independent of phonological
awareness” (p.147). Even after controlling for rapid naming and verbal short-term memory, the correlation was still considerable.

The second part of this study was designed to investigate whether there is a connection between VAS and spelling skills, whereas other studies focused entirely on reading skills. The sample for this comprised of 255 children from fourth grade with the same native language (Dutch) and a mean age of 9 years. As Word reading fluency was again measured with the One Minute Test. The Klepel test was administered to test for non-word reading. The Klepel test, another commonly employed method in Dutch primary schools, is a timed word reading tasks, where students have to read aloud a word list within 2 minutes and the number of accurately named items comprise the final score. Furthermore, “orthographic knowledge was assessed with an orthographic choice task” (p144). In this tasks the participants were exposed to a word with 3 alternatives in terms of spelling, and among these 4 items they had to choose the correct one “(e.g., haut hout houd haud; for the word ‘hout’, meaning wood)” (144). Again the scoring took place on the basis of the number of accurate responses. PI dictee, a spelling test, was used to measure spelling skills. For this task the students would hear 45 already acquired lexical items which they had to write down. Similarly to the orthographic task, the number of accurately spelled words out of 70 comprised the final score. Finally VAS was assessed with a whole report task. Again VAS proved to be a reliable contributor to orthographic and spelling skills. Both “word and non-word reading” were significantly correlated with VAS, which explained additional proportion of the variance regardless of phonological awareness (p.145). Phonological awareness, as expected, was a “strong predictor of word and non-word reading fluency” but VAS was equal in terms of prediction of reading skills (146). Finally, a hierarchical regression revealed that VAS explained a considerable amount of the variability in spelling performance
Another study designed to investigate the VAS as an influential factor in the acquisition of reading skills, was the one conducted by Germano et al. (2014). To that end the researchers recruited a sample of 66 subjects, with a mean age of 11 years old and Brazilian Portuguese as their native language. Since disruption in the development of reading skills has been associated with developmental dyslexia, 33 of the participants were dyslexic and the rest comprised the controlled group. The outcome of the study revealed that the dyslexic participants did not suffer solely from a phonological deficiency but also from a VAS impairment, especially in multi element processing. Moreover, “three phonological tasks” were significantly correlated with “two visual processing tasks” (p.7). Significant correlations were observed between both cognitive abilities and reading performance revealing that they independently influence reading development. The findings of Germano et.al., highlight the importance of including VA measures in addition to phonological when exploring dyslexic participants, regardless of the language's orthographic transparency. Overall their experiment demonstrated that VAS and phonological skills are two independent constructs that both contribute to reading development and each one was responsible for “unique variance in reading fluency” (p.7).

3.2.2.1 Summary of the VAS literature

VAS while a recent addition to the predictors of literacy development proved to be a strong predictor of reading and writing skills. Additionally it is an ability that explained a significant amount of variance in literacy skills independent of other skills related to them (e.g. phonological awareness, rapid naming etc). Language transparency was also something that the conducted studies took into consideration and revealed that it VAS deficiencies may occur regardless of orthographic transparency (Germano et al., 2014). Despite the fact that VAS has not been extensively tested (as compared to
phonological awareness) it was confirmed that a VAS deficit can be the cause of learning difficulties, even when phonological skills are properly developed (Valdois et al., 2014; Lobier et al., 2011). Finally as it was mentioned by Valdois et al., VAS is a skill that can be subjected to intervention and it can positively affect the reading process. Since was found to be highly correlated with reading skills, a training on that aspect will held impaired readers improve their skills.

3.3. The combined explanatory power of phonological awareness and VAS

When taking into consideration the available literature it is evident that both constructs are essential to literacy development and independently of other factors (such as rapid naming, age, or language transparency). Studies that examined the contribution of both are scarce, but the ones that do exist provide evidence that phonological awareness and VAS constitute two independent variables in the reading and writing process, with the VAS being absent form writing development (Bosse et al., 2007; den Boer et al., 2015). Valdois et.al. provided further support for this argument in the context of dyslexia when their case study revealed that their subject was VAS but not phonologically impaired.

More specifically, the VAS studies were often already carried out with an eye of proving that dyslexia is not just governed by phonological awareness deficits but also or perhaps even more by VAS. That was in fact a finding that some studies corroborated. Valdois et al. (2014), and Bosse et.al., designed experiments that produced evidence that a VAS deficit may exist and may lead to dyslexia in absence of phonological deficiencies. However, which one is the undisputable cause of language impairments is still to be answered.

Phonological awareness is a cognitive ability that has been associated with successful literacy development for decades and has been thoroughly tested, rendering its
contribution unquestionable. Despite all these years of investigation there is still one issue that has been ignored from the largest part of the relevant literature and this is the contribution of phonological awareness to writing skills. The studies discussed in the present metastudy are the most recent in order to incorporate the latest findings. That is not to say that writing had been sufficiently investigated and that no further assessment is required. Writing skills are equally important to reading skills so that successful literacy development is achieved thus knowing how and by which constructs they are influenced is crucial.

Moreover, phonological awareness is tapped using a myriad of different tests and there is some evidence that not everything is similar, such as rhyming ability being distinct (de Jong & van der Leij, 2003). This idea emerged from the fact that in their experiment de Jong and van der Leij (2003) discovered that in some dyslexic participants phonological deficits were detected while rhyme awareness issues—that were previously present—had disappeared. So far phonological awareness has been attributed a clear structure but this raises the question of what exactly phonological awareness is. Could it be that it is a broader structure that incorporates a number of other constructs? Also, since rhyme awareness seems to be separate from phonological awareness maybe it should not be a measure of this cognitive ability.

VAS, as opposed to phonological awareness, is much less clearly established as a predictor, although the evidence has overwhelmingly shown that it is important and that it is important independently of phonological awareness. Studies designed to examine both abilities are skewed in that VAS, despite only being recently taken up. This maybe be due to the undisputable correlation of the VAS with literacy development or merely a trend. In either case this correlation needs to be even more investigated. Another difference that is spotted among the two abilities is the fact the VAS is much broader applied. While
phonological awareness has been associated with reading almost exclusively, VAS has been investigated in relation to writing, reading as well as copying skills. Finally, the age group is considerably larger, including adults, a group that has been widely ignored by phonological awareness literature.

What was true for phonological awareness is perhaps even more crucial for VAS: in a time where researchers are actively trying to uncover the individual components of broader constructs, it needs to be determined more accurately what exactly VAS is. It has been suggested to comprise processes like visual attention, but also visual processing, rapid naming, working memory, etc. Factorial analysis type investigations, trying to more carefully detail the components that make up VAS would greatly benefit our understanding of the construct and with that how VAS influences literacy development.
Chapter 4. Next stop – The future

Phonological awareness as well as VAS are two influential and independent contributors to the development of literacy skills such as reading and spelling. Whereas not too long ago, phonological awareness was treated as the primal factor influencing literacy skills, in more recent years VAS has also claimed its stake as pivotal, with more explorations being needed to uncover its precise nature. So far the present study has looked into the available literature that was produced during the last 13 years. In this section we will attempt to provide suggestions as to what future studies could investigate and how the already existing findings can be implemented in instructional settings.

4.1 Future studies

Although the past decades has seen ample experiments to investigate phonological awareness and establish its relationship with literacy development, a rather small window of age of the target group can be observed. The majority of the studies focus on children that are in the initial steps of literacy development (or indeed at a precursor stage), leaving the adolescent and adult population vastly understudied. One might wonder why is there a necessity to look into the adult population since we can assume that whatever findings in children can also be directly applied to adult populations. However, this may not be the case. As already been proven by Talwar et al. the two age groups (children and adults) employ different skills when it comes to spelling; adults tap into their phonological skills while children cannot do so until they have acquired “phonological representations” (2009, p.44). Such differences between the two age groups are worthwhile to more closely investigate, especially in relation to phonological awareness. The same applies for the
VAS. Although a slightly larger age window is examined in VAS studies, adult populations do not form the focus of any study. It should be noted though that the VAS is a very recent as compared to phonological awareness which justifies the lack of diversity in terms of age. What would constitute an interesting comparison would be one among TD adult and language impaired populations in terms of both phonological awareness and VAS. Developmental dyslexia is known to be a persistent problem, staying with a person throughout his or her lifetime, but even though it cannot be eliminated there are strategies that can assist in literacy skills improvement. By directly comparing TD and dyslexic adults to child TD and dyslexic groups we would be able to uncover details on how deficits in phonological as well as VAS deficits progress over time and the different ways they may manifest in the two populations. To that end it would be ideal to design a longitudinal study that follows the subjects, tapping their performance on both abilities, from primary school years to adolescence and finally, early adulthood (early 20s). Such a study would provide interesting information on how these abilities influence literacy development but also whether they constitute dynamic constructs that change over time.

Another aspect of literacy that has been largely ignored in past investigations is spelling and the degree to which it is influenced by phonological skills. Being able to spell is equally important to successful literacy development than being able to read and yet it is absent from the majority of the conducted experiments. In the present meta-study only the experiment designed by Talwar et al. (2009) targeted the influence of phonological deficits in spelling. The VAS literature has also largely ignored writing skills, albeit that slightly more studies in this domain take it on board. However this may not be due to lack of interest but due to the fact that VAS may not be connected to being able to write, as indeed previous investigations have suggested. Taking the VAS definition into consideration one is able to see the connection between this and reading skills. In order to
read a word one has to be able to attend to all letters that comprise it. On the other hand, writing seems to depend mostly on symbol sound mapping i.e. phonological awareness. So, at first it appears that the VAS plays no role in writing. However since this is just speculative at this stage, it would be interesting to further examine this and more firmly establish whether there is a connection or not.

4.2 Pedagogical implications

Apart from the fact that the two constructs proved to be independent contributors to literacy developments, another important outcome that has surfaced in this metastudy needs to be taken into consideration and that concerns the intervention that could be done to improve both phonological awareness and VAS abilities. Certain studies that explored both cognitive abilities revealed that when a deficit is exhibited an intervention in the relevant domain will be beneficial. Ritter et al. (2013) proved that impaired students who receive additional instruction to enhance their phonological awareness improved their phonological skills and consequently their reading performance. Similarly, Valdois et al. (2014) implemented a VAS intervention that positively influenced the subject's reading abilities. Both outcomes provide useful guidelines for teaching students with deficits in either skills. Even though phonological awareness as well as VAS deficits would appear hard or impossible to overcome (depending on whether the population under investigation are ‘mere’ poor literacy learners or diagnosed language impaired), it is very important to know that there is a way to minimize their effect on literacy skills. However, since the VAS had been added recently to literature further investigation is required to replicate the same finding and support the effectiveness of an intervention.

When discussing an intervention that aims to either phonological awareness or VAS the first thing that needs to be done is determining which aspect is impaired. In
language impairments such as dyslexia, it has been proved that a VAS deficit does not presupposes a phonological deficit. Yet what is observed when it comes to teaching is that phonological awareness intervention is viewed as the sole way of improvement. This means that if all dyslexic students are treated based on the premise that dyslexia equals phonological deficits valuable time will be wasted trying to improve something that may not have been impaired in the first place. After the deficit has been identified (a VAS deficit, a phonological or a combination of both) then we can decide on the method to be followed. As it was proven by relevant studies intervention in phonological and VAS abilities can have a positive impact on reading development (Valdois et al., 2014; Ritter, et al., 2013).

Finally, the outcome of the instructional approaches experiment by Aravena et al. (2013) provides useful information that can benefit both language impaired and TD learners in terms of phonological awareness. In the early stages of the emergence of phonological awareness both populations would benefit greatly by an instructional method that incorporates explicit learning prior to implicit instruction. As they discovered dyslexic as well as TD participants more easily acquired the necessary symbol-sound combinations when instructed with both approaches. In terms of effectiveness, implicit instruction was characterized as the most inefficient. This is something to be kept in mind when designing a teaching approach designed to promote phonological awareness.
Chapter 5: Conclusion

This study has attempted to provide a metastudy of the most recent studies designed to examine the influence of phonological awareness and VAS to successful literacy development. With the field being at a crossroad of, one the one hand, many studies already having confirmed the importance of phonological awareness and, on the other hand, the relatively newly introduced concept of VAS, now was a good time to conduct such a metastudy. The main outcomes showed that phonological awareness is in fact a strong predictor of and a contributor to literacy skills (i.e. reading and writing). Once more it has been proven that it is this construct that is responsible for the successful acquisition of reading and writing skills and that learning impairments emerge as a result from a deficit in the ability to form letter-sound associations. On the other hand the VAS, constitutes as well an independent predictor of literacy and can be responsible for dyslexia even when a phonological deficit is not present.

There are limitations to this study that need to be pointed out. First of all, whereas the VAS literature review could be exhaustive due to the small number of studies that have been conducted so far, this proved impossible in the case of phonological awareness. Whereas a conscious choice was made only to include the most recent studies (having appeared in the last 13 years) and the most influential ones (based on citation indexes), such an approach does mean that a substantial number of studies remain unreviewed. In addition, this was a first metastudy, but future endeavours could also include more quantitative ways of conducting such an investigation, by also focusing on effect sizes of different studies, for instance, and in this way uncovering more about the weighted contributions of phonological awareness and VAS on literacy success.

In short, much still remains to be explored and ample suggestions for future directions have been provided in section 4.1 above. Perhaps more than anything else, it
remains important not to lose sight of the pedagogical implications that research on these constructs have. Perhaps surprisingly, the number of studies looking at the nature of the constructs themselves far outnumber the intervention studies targeted to improving phonological awareness and VAS skills. Especially as both are directly relevant for language impaired situations, every effort should be made to make the life of dyslexic students easier, in their mother tongue education but most definitely also in the foreign language classroom.

*It is all very well to describe, clinically and unemotionally, the nature of these impairments, but imagine waking up one day and discovering that it has happened to you. Or imagine growing up and losing out at school because you could not take notes easily, or could not understand the teacher, or could not express yourself adequately. Imagine your child having to grow up that way. (...) For most of us, the ascent of our own personal Babel is unimpeded, and we should be thankful for that* (Altmann, 1997, p. 204).
References


