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## **Assessing assistive technology requirements in children with written language disorders.**

### **A decision tree to guide counseling**

Short title: Assistive technology for children with written language disorders

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## **Abstract**

Children with a written language disorder are sometimes dependent upon help from others for their schoolwork. A computer can be a way to circumvent this difficulty.

Various software programs and plug-in peripheral devices are available, some of which specifically target the needs of these young people. There is no consensus, however, with regard to how best to counsel parents and children with regard to these tools. Furthermore, written language disorders and existing technical supports are not always clearly understood. In many cases, healthcare and teaching professionals have only limited knowledge of the potentially specific advantages for patients with written language disorders. A child's full integration into daily activities and school life can be hampered by counseling that was inadequately tailored or by a lack of support in using this equipment.

Joint consultations involving both an occupational and a speech therapist have been set up in our department to improve counseling with regard to technical supports.

Using our daily practice as a basis, we have developed a decision tree that we see as a necessary tool for helping professionals make the most appropriate practical choices.

**Keywords:** Dyslexia, assistive technology, counseling, multidisciplinary approach, occupational therapy, speech therapy

## **1 Introduction**

The inclusive education approach has been applied by the teaching profession in France since the law of 11 February 2005 on “Equal Rights and Opportunities, Participation and Citizenship of Disabled Persons” [1]. Instead of enrolling children with learning difficulties in special schools, the teaching methods are tailored to their needs: any activity limitations should be compensated for to ensure that all pupils have the same opportunities, thus ensuring academic achievement for all.

Compensation strategies for students with written language disabilities can include differentiated instruction, as well as pedagogical tools and equipment proposed by the teacher [1], all of which have been scrupulously described in the literature. These can include varying the type of supports, simplifying visual information gathering using extra-wide letter-spacing, preferential use of spoken language, limiting the use of written language, avoiding the use of copying exercises, providing additional time or limiting the amount of work required, accepting spelling mistakes, and setting up a tutoring system [2,3].

These provisions may not always be adequate to compensate for the most severe disabilities and may often prove complicated for the teacher to implement.

Assistive technology will therefore be considered if traditional adjustments cannot be provided or do not provide adequate support for the child, but also to compensate for moderate writing disabilities. However, there is no framework protocol for counseling on this type of support and we have observed significantly different approaches.

In this paper, we present an inventory of the currently available assistive technology, with a number of considerations relating to their advantages and limitations for children with written language disabilities.

In light of recent publications in the literature, we will describe the counseling approach that we have set up at the Regional Centre for the Diagnosis of Learning Difficulties (Centre Régional de Diagnostic des Troubles d'Apprentissage [CRDTA]) in Lille (France) and the protocol that we developed, from the diagnosis to the prescription of assistive technology.

## **2 Specific tools to address written language disabilities**

The ISO 9999:2016 International Standard defines an assistive product as “any product (including devices, equipment, instruments and software) especially produced or generally available, used by or for persons with disability, for participation; to protect, support, train, measure or substitute for body functions/structures and activities; or to prevent impairments, activity limitations or participation restrictions.” The technology for assisting children with written language disabilities is designed to improve their communication skills and includes not only a computer but also dedicated software and plug-in devices [4].

Assistive technology should be suggested at the end of primary school to ensure the child has learned to handle the device both comfortably and effectively by the time he moves into secondary education. This is also the best way to ensure he has acquired sufficient maturity to be able to use it unaided, but has also had the time to undergo effective speech therapy with all the prerequisites for written language acquisition [5]. To ensure each child consents to using the device and adopts it successfully, any software must be specifically tailored to each type of disability [5,6].

### **2.1 Compensating for reading difficulties**

The most widely used technology is a speech synthesizer that reads aloud a text displayed on a computer screen. Typically with this type of software, the text that is to be read must be displayed in an editable PDF format using optical character recognition technology.

There are various types of remedial reading software including features such as displaying different syllables or phonemes in color, highlighting alternate lines, visible page-margin marking, screen rulers, larger font size to limit visual confusion, and extra-wide letter-, word- or line-spacing. To date however, only wider spacing between letters has been shown to be effective [7].

These different adaptive techniques are appropriate for understanding instructions or short texts, whereas children who wish to read novels can use libraries that stock audio books.

## 2.2 Compensating for writing difficulties

Software programs that provide writing support for children who have mastered the phoneme-grapheme correspondence enable them to use the skills they have acquired while at the same time compensating for their disabilities. These different types of software are suitable for children with mild to severe disabilities and will now be presented from the most simple to the most elaborate.

For certain children the main difficulties are spelling and grammar. Printed text enables them to get round this because it is easier to follow from a visual perspective. They can also use a spelling corrector, an electronic dictionary or conjugation tables, which all make it easier for them to concentrate on the task at hand.

For more severe disorders (inability to identify words, sound confusion), word-prediction programs can suggest a list of words, automatically correct the lexical and phonological mistakes and also read the list aloud. If the prediction-mode makes the typing process too slow for the child, the program can be used as a spell-checker at the end of the session. Incorrectly spelled words are displayed in color and the child has access to a list of suggestions: he then selects the word he intended to write.

A screen-reader (audio feedback) can be used as a supplement to these software programs. These systems read the text aloud either while it is being typed or after: text is therefore easier to read through and the child can identify and self-correct certain phonological mistakes (provided she does not have an auditory processing disorder) as well as any letters that may have inadvertently been forgotten or added while the text was being typed.

Certain all-in-one software programs offer multiple resources to assist in reading and writing tasks in a single word-processing program, and these are specifically useful for children with the most severe disabilities. They may prove less user-friendly and more complex to use however.

Lastly, speech-recognition programs enable a child who is unable to convey his ideas via written language to take advantage of his oral language capabilities: the computer screen displays the words that the child dictates. Speech-recognition errors can occur frequently however, meaning that the text needs to be corrected either by a third person or by another software program. Moreover, speech-recognition is only really applicable for homework and is of no use for individuals with a speech disorder.

### 2.3 Other equipment

A scanner is often a necessary piece of equipment for individuals with written language disorders. A portable wireless scanner allows children to scan documents even if a computer is not available. The scanner can then be connected to the computer once the child returns home. This type of device requires good motor control and several steps have to be accomplished before the scanned text can be read aloud via a speech synthesizer. It is therefore better suited to compensating for a written language disability than reading difficulties. The hand-held mouse scanner can only be used when it is connected to a

computer. It is easier to manipulate, however, and the scanned image is displayed in real time on the screen and can easily be imported into the speech synthesizer program.

Depending on the child's needs, a printer, an audio headset, and a microphone headset may also prove useful.

There are as many different equipment options as there are patient profiles [5]. In some cases, nonspecialist equipment (photocopiers or portable scanners without a computer, a standard word-processing spell-checker, standard word-prediction without a voice synthesizer or pictograms, extra-wide text spacing to simplify reading without the need for optical character recognition) are sufficient. The child is less stigmatized in class, has less to learn in terms of manipulating new equipment, and the overall equipment costs are thus limited [8].

### **3 Potential obstacles to the use of computer devices**

Bacquelé et al. from the University of Lyon (France) conducted a study on children with written language disabilities (with and without associated disorders) and reported that of a total of 52 children who had access to a computer, 28 only used it at home and nine never used it [6]. According to this study, only 25% of these children were able to benefit from the help of an occupational therapist to help set up the devices. Teaching assistants were present for only 40% of pupils. The majority of children became accustomed to using their assistive devices at school assisted by a friend or relative [6].

Several hurdles to the use of assistive technology have been identified:

- the fact that it stigmatizes the disability;
- the cost of the equipment;



- the human resources that are required to provide a framework for learning to use the equipment (occupational therapist);
- the human resources that are required to help students settle into mainstream classes (teaching assistant, occupational therapist, teacher availability, a monitor, and a dedicated room if the child works on exams using a speech-recognition program);
- the specific characteristics of the equipment that make it more or less easy to use (ergonomics, time required to set it up, and the time required to install the software program);
- how quickly the child learns to use the device, how long it takes him to adopt the necessary automatic reflexes, and how mature the child is, whether he is able to use it easily and without assistance;
- how accessible the device is as a teaching tool, because even when the child is familiar with it, he may require extra time: teaching aids used in class are not always easily adaptable to the computer and thus may require specific preparation [5,6].

These observations highlight the need to ensure that support is available to the family and the teaching staff to help them overcome any difficulties, both in terms of organization and time, that are likely to be encountered as the child learns to familiarize himself with the computer. The occupational therapist is specialized in the assessment of autonomy, counseling, and setting up technical aids to help students with learning disabilities and is therefore competent to simplify access to computer tools [9]. Not only does the occupational therapist ensure that the child receives the most appropriate counseling (support devices suited to classroom use and to the learning tasks proposed by the teacher, with allowances for the child's particular skills), but she also checks that the device is correctly configured and provides tailored instructions as to how it should be used.

Once the initial explanations are over, even for a child who acquires a certain level of independence in terms of actually using the computer, it is unlikely that he will spontaneously think of using it. The presence of a teaching assistant may prove necessary to instigate appropriate use according to the learning task. By limiting the number of writing tasks required, enabling the child to photocopy certain lessons or allowing extra time to complete specific tasks, the teacher can help the child to see the computer as a normal classwork tool and use it spontaneously.

## **4 Counseling**

### 4.1 A multidisciplinary approach

Because the choice of assistive technology is based on a holistic perception of the context, counseling has to be based on a multidisciplinary assessment of the feasibility of the project, and a sound knowledge of:

- all the existing tools, including their advantages and limitations;
- the type of disability, how the child compensates for his specific learning deficits;
- the child's psychoaffective profile (capacity to accept the equipment and recognize its potential benefits: motivation, maturity, awareness of her difference);
- the child's environment (family support, school setting, any specific adjustments made by the teacher);
- the child's actual activity limitations [5,8].

The type of disability, the effect it has on the child's schooling, and the extent to which he capitalizes on his capabilities to compensate will all be documented by the occupational therapist. Likewise, the teacher will report on the school environment, and the nature and impact of the disability.

The psychologist and the physician will both assess the child's maturity, motivation, and commitment, as well as the extent to which he can rely on the support of his family. Based on the observations of the different professionals involved, certain specific teaching aids can be identified. An occupational therapy assessment will likely be suggested, and this will identify the most appropriate assistive technology.

#### 4.2 The child and the family at the center of the project

Assistive technology can be costly to set up (cost of equipment and of occupational therapy), but it is also demanding in terms of time and personal investment [8]. Ensuring that the child and his family adhere to the project and are actively involved in selecting the assistive technology is crucial to successful integration on a daily basis. It may be better to tell the families about what is available and let them get accustomed to the idea first, and then during a more formal assessment, explain which device actually corresponds to the child's needs [5,8].

If the child's comments are genuinely taken into consideration during the discussion about her difficulties and also when the new device is being tested, she will really feel she has an important role to play in the project.

The child's parents and speech therapist may have noted a specific disability that the child is not aware of. It is therefore important that they are there to help the child with the new device on a daily basis. This naturally implies that they must also be involved in documenting the child's specific difficulties and also in the final choice of equipment [5].

In summary, given that every child has his own specific complex features, any decision regarding his care should be based on the WHO International Classification of Functioning, Disability and Health (ICF) (Figure 1) [10]. This biopsychosocial approach to disability

encompasses not only the child's medical profile, but also the impact of social and environmental factors, thus enabling a collaborative language to be used by all parties involved. It summarizes and assesses interactions between the context (environmental and personal factors), the disability, activity limitations, and restrictions in terms of participation [11].

### 4.3 Prescription

#### 4.3.1 Occupational therapy assessment

The occupational therapy assessment requires a sound knowledge of the software programs available and should take all the recommendations of the multidisciplinary team into consideration. The formal assessment focuses on the patient, her activities, needs, and expectations, and can be based on the Canadian Model of Occupational Performance and Engagement (CMOP-E) [12].

The assessment includes both an interview and tests of direct interaction in a practical context to identify the specific features of the individual and his environment that either simplify or hinder his ability to accomplish activities that require the use of written language [13].

The in-depth interview with the child and her parents highlights the activity limitations that the patient encounters (difficulties experienced, and situations where she still relies upon another person despite existing adjustments). It is also an opportunity for the therapist to question the child about the extent to which she is familiar with or interested in her computer, as well as her expectations and projects.

The child's needs can therefore be identified and appropriate adjustments suggested. Real-life situations are simulated so the child can try different devices and assess the extent to which

they help him overcome his difficulties [5,13]. The therapist can check the speech recognition function, and see how well the child manages to read back the text and grasp the meaning. For the therapist's counseling to be individually tailored, it must take into consideration the different locations where the equipment will be used (school environment but also leisure activities) [6,8] and consider these in the light of his different activities. To avoid the computer being left unused, carers should consider how best the suggested equipment can be set up in the child's own environment. For example, although the child may easily be able to use speech-recognition at home, particularly for his hobbies, it will not only be more problematic in the classroom, from both human and material perspectives, but also more stigmatizing.

#### 4.3.2 Necessary occupational therapy follow-up

Short- or medium-term occupational therapy follow-up will be scheduled after the assessment, concurrently with the speech therapy rehabilitation, to ensure the child has learned how to use the device correctly and has progressively assimilated it into her everyday activities and school life.

Because multidisciplinary teams have very little experience with this technique, we have been unable to find any specific description of the process in the literature. On the basis of our own practice and that of other practicing specialists in Lille (France), we estimate it takes a motivated child with sufficient family support approximately 1 year to learn how to use assistive technology correctly. However, even if the device is properly used during session times it does not necessarily become instinctive and children may not necessarily think to ask for help when they could or should in everyday situations. Children also have to learn to react quickly and independently in order to keep up in class. The occupational therapist and the teaching staff can decide together how and when the computer should best be used to ensure it

is successfully integrated into classroom life. Details of the arrangements can be included in the Personalized School Plan (PSP), to ensure that all the teaching aids are accessible, the child is self-sufficient, the school program is followed, and the teacher's demands are respected.

This is the point where the occupational therapist—and the working relationship he has established with the child's family—have a particularly important role to play. They must work with the child to help him put what he has learned into practice, and to learn how to take full advantage of the specific adjustments that have been made to his environment; these will serve as a basis for his future independence in both his personal and professional activities.

## **5 Counseling as implemented at the Regional Center for the Diagnosis of Learning Difficulties (Centre Régional de Diagnostic des Troubles d'Apprentissage [CRDTA] in Lille (France)**

### **5.1 How the Center is organized**

At the Lille referral center, assessment sessions with a view to recommending assistive technology were initiated in early 2015. First, the child undergoes a multidisciplinary assessment with a neuro-pediatrician, a neuropsychologist and a speech therapist, the outcome of which will be the diagnosis of a specific or nonspecific written language disability. Based on the personal and environmental factors previously discussed, assistive technology will be recommended. The specific features of the equipment corresponding to the child's requirements and how it is to be used are explained during a further occupational therapy assessment including an interview and practical application exercises.

### **5.2 Case reports and counseling in the choice of suitable educational equipment**

In clinical practice, the question is whether the child should make use of a speech synthesizer, a scanner, or handwriting, and whether text-prediction software or a spell-checker would be more suitable. Our experience has shown that in terms of accessing autonomous reading and writing skills, each type of software or plug-in device (whether or not it is specialist equipment) and its practical applications can be correlated with a specific occupational profile.

We have developed a decision tree as a guide for counseling (Figure 2). It provides a clear demonstration of the complexity of recommending assistive technology, and more specifically of the debate that can arise from occupational therapy assessments (Figures 3 and 4).

For a child with a reading disorder but no spoken language deficits, whose main difficulties with written language are phonological deformations (decoding), and who has no major difficulties with segmenting or syllable omission, only text-prediction with a corrector that allows for phonological errors and includes a speech synthesizer can be used. The occupational therapy assessment interview will highlight whether or not a speech synthesizer should be used systematically, only for long texts, or just for instructions. By interacting with the child in a practical context, the therapist can identify the most appropriate software according to its interface, how easy the different programs are for the child to use, and how and when they are to be used as a spell-checker or text prediction, with or without speech synthesis.

A spell-checker and grammar correction software (proofreading programs) may be useful for a child whose written comprehension is hampered by impaired reading fluency, and who also makes syntax errors when writing. Once again, by interacting with the child in real-life situations, the therapist will be able to determine whether or not classic word-prediction software is likely to be of help and what type of reading visual aids will be useful. During the

occupational therapy interview, it can be decided whether visual aids for reading are required systematically, and therefore whether a mouse-scanner or a hand-held device is more suitable.

A computer is rarely the best option for a child with a minor disability, who manages to write and whose writing is legible but is too slow and who is penalized by difficulties with syntax, for example, reading over his own notes taken with spelling mistakes, losing marks during classroom tests, insufficient time to finish, etc. An occupational therapy assessment is therefore not always required. Differentiated instruction but with adjustments to exam situations can prove adequate. A framework of exactly how and when the computer can be used will be specified based on the data collected during the interview. Often in this type of situation, the computer will only prove necessary when the child goes to high school where substantial amounts of handwriting are required; in that context, the child should be encouraged to write by himself if the exercises only require short answers or gap-filling in texts.

Audio note-taking/speech recognition is a mandatory tool for children who are unable to write. Depending on the age of the child, the speech therapist's long-term prognosis will guide the decision to opt for an all-in-one software program in the hope of encouraging the child to write, thus enabling him to attain a certain level of independence in class, particularly if there is no one available to help.

Whether or not assistive technology should be used in specific situations should be determined on a case-by-case basis, depending on the child's capacity to compensate for his specific deficits, on his psychoaffective profile, and how he manages to adapt in difficult situations. An anxious child with a severe written language disability may find it difficult to identify the correct spelling from a list of words: a child such as this would benefit from spell-checker software even though it is less reliable than a corrector offering multiple choices. A



child with the same written language skills but with a greater capacity to adapt and better compensation strategies will be able to gain a certain level of independence and capitalize on his stronger points by using a speech-synthesizer/screen reader and a standard spell-checker.

## **6 Conclusion**

Any counseling on the acquisition of assistive technology must be backed by multidisciplinary evidence. The physician, neuropsychiatrist, pediatrician or school doctor will make the diagnosis, study the situation in its entirety, decide whether further assessments are required, and summarize the feedback of each member of the paramedical staff. The speech therapist has a sound knowledge of written language disabilities and can thus assess the patient's language profile and her capacity to compensate for this disability. The psychologist determines the child's overall cognitive profile with her strengths, weaknesses, and psychoaffective profile. The occupational therapist proposes a patient-centered approach, focused on her individual constraints and environmental limitations, her activity restrictions and the level of productivity she is likely to achieve with the assistive technology suggested.

The full potential of assistive technology for children with written language disorders remains largely unknown to parents, but also to certain teaching staff and healthcare professionals. There are also the worries aroused by this kind of equipment: fear of what others may think, fear of an extra work load for the teacher, fear that a computer alone will not get round the specific spelling difficulties encountered by dyslexics, but above all the fear expressed by parents, that their child stops trying and therefore stops progressing. Better information is required by both families and healthcare professionals; this could be delivered through training or more simply, when the disability is diagnosed, via systematic distribution of

leaflets explaining the different types of assistive technology that are available. This would help both children and their parents to understand and acknowledge the diagnosis, and provide healthcare professionals with a better overview of the support that innovative technology can provide.

Prescribing this type of device must be both methodical and systematically tailored to individual requirements. Medium-term, a longitudinal study is warranted to assess the effects of assistive technology on patient outcomes, not only in terms of educational achievements, but also with regard to progress in written language skills.

The different options presented in this paper are based on ever-evolving technological innovations. Regular reassessment of practices is crucial to the success of counseling for children with written language disabilities in the acquisition of the most suitable remedial device.

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## Figure legends

**Figure 1.** International Classification of Functioning (ICF) and written language disabilities.  
ICF summary developed by the World Health Organization (2001)

**Figure 2.** Counseling in assistive technology

### Legend

- Individual factors
- Activity limitations
- Environmental factors
- Solutions suggested

PSchP: Personalized School Plan

PSpP: Personalized Support Plan

SSD: Support for students with disabilities

**Figure 3.** Counseling on remedial writing assistive technology

Legend

■ Activity limitations

■ Written language profile

■ Solutions suggested

*Severe* Hinders comprehension

*Moderate* Potentially legible with adult “goodwill” but substantial dysgraphia

**Figure 4.**

Counseling on remedial reading assistive technology

Legend

■ Written language profile

- Activity limitations
- Solutions suggested

**Health problem:**  
written language disorder

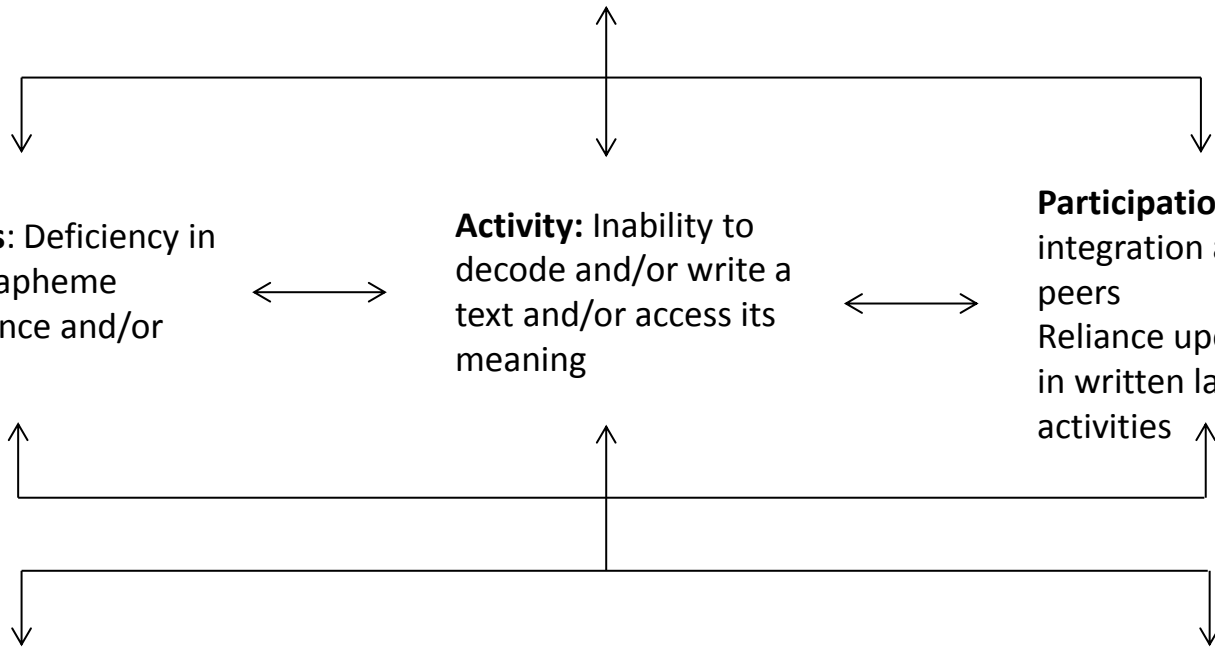
**Impairments:** Deficiency in phoneme-grapheme correspondence and/or processing

**Activity:** Inability to decode and/or write a text and/or access its meaning

**Participation:** Poor integration among peers  
Reliance upon others in written language activities

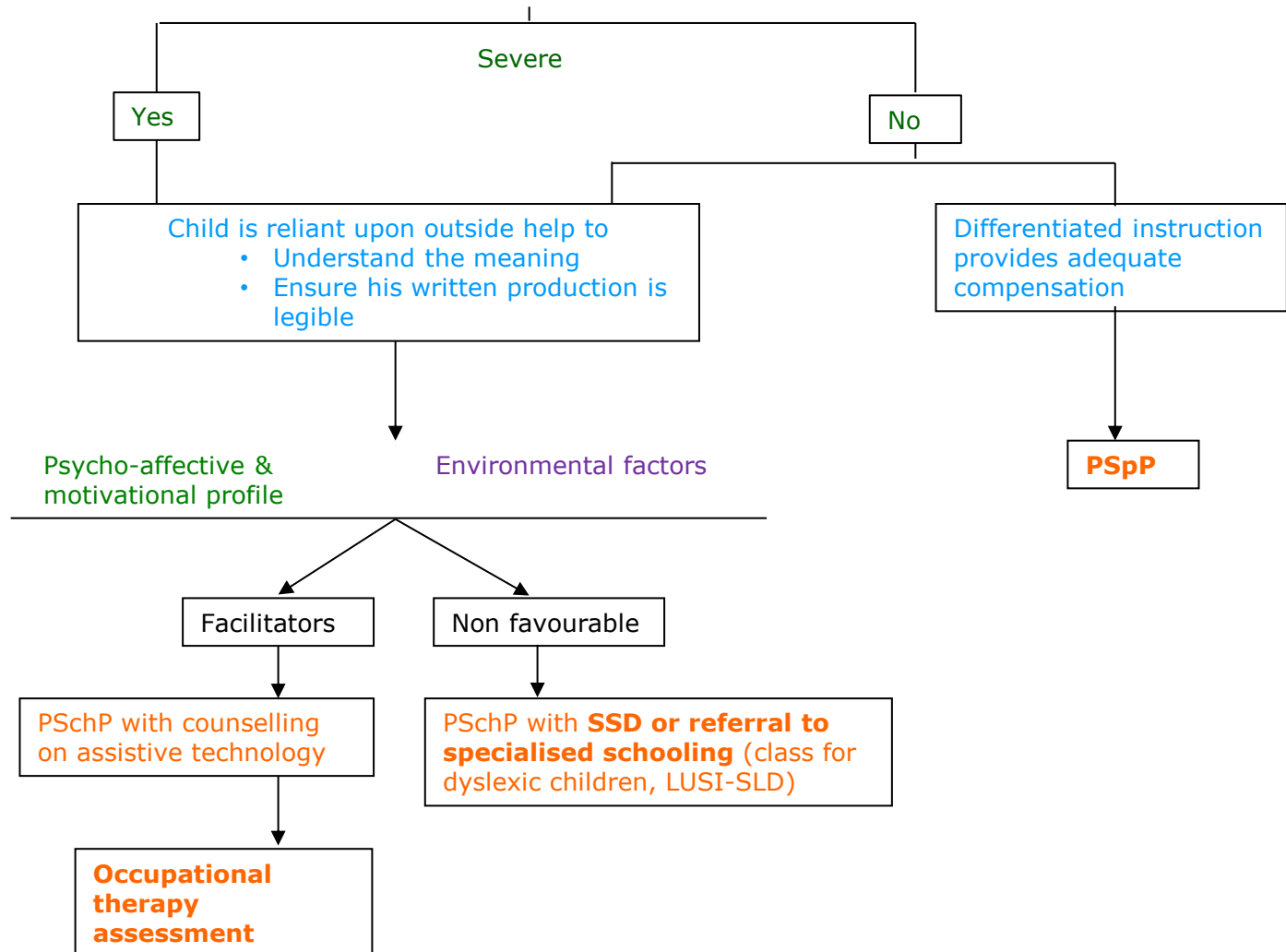
**Environmental factors:**  
Adaptations in place, type of schooling, family support, caring friends, etc

**Personal factors:** Life-style, expectations, maturity, compensatory resources, etc

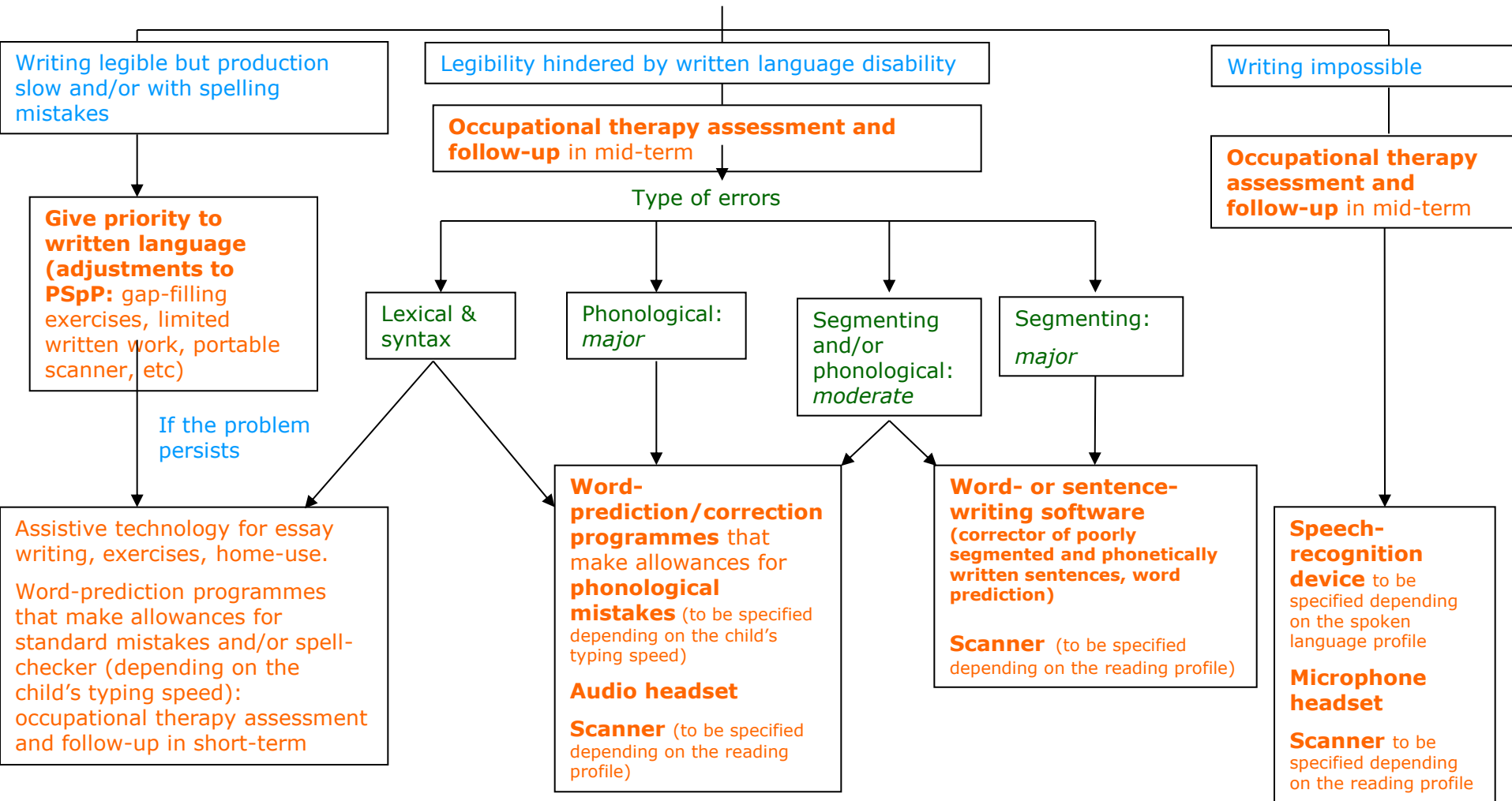




## Written language disability



# Writing legibility



# Reading comprehension deficit

## Reading comprehension

