AN IxD SUPPORT MODEL WITH AFFECTIVE CHARACTERISTICS FOR DYSLEXIC CHILDREN'S READING APPLICATION

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ABSTRACT. This paper listed affective attributes of an interaction design for a reading application meant for dyslexic children. Different reading styles and unique reading approach of these specific children has long been a challenge for designers to come out with an acceptable interaction design (IxD). Emotional characteristics towards reading such as likes, dislikes, motivation, and satisfaction, which are very much related to affection, are essential in designing the suitable reading application to help them in learning to read and increase their interest in reading. A series of observation and unstructured interviews were conducted involving 28 dyslexic children, whose age range from 7 to 14 years old. The finding reveals that we can combine the affective attributes of the dyslexic children with the interaction model based on Norman's work to map specific requirements suitable to dyslexic children's reading ability. This inventive IxD model is proposed for readers with dyslexia. Additionally this paper shows how we translated such model into an automatic reading tutor for special need learners.

Keywords: Interaction design, affective engineering, interaction model, dyslexic children reading application.

INTRODUCTION

Reading, for dyslexic children (DC) is such a challenging task, even for simple words. Due to their difficulties in reading, dyslexia is perceived to be a deficit in the acquisition of sufficient skills for the aforementioned task due to phonological deficit theory (Lundberg, 1995; Shaywitz, 1996; Snowling, 2000; Wolf, 1999). Thus, significant efforts have been put forward to help them read from conventional teaching methods to computer-based application (Lundberg 1995; Lundberg & Olofsson, 1993; Olofsson, 1992; Olson & Wise, 1992). Since reading is such a challenge, having an automated reading tutor (ART) is therefore concerns very much on the affection of such tool to create interest and likable factors towards reading. Affective aspect of a reading tutor is the key that influence the positive emotion of these children (Te'ni, Carey, & Zhang, 2007). Hence, to ensure the effectiveness of an ART, the application must adapt interaction design model that fit specifically to these special need learners. The model should take into account the affective attributes of the children, prior to translating them into ART.

Theoretically, affect is referred to as a valence subjective experience involving positive or negative perception or pleasing or displeasing feelings (Desmet, 2007). The valence subjective experience serves as a basis of the core affect theory (Russell, 2003) as depicted in Figure 1. The hedonic dimension (horizontal line) represents pleasure and displeasure whereas the activation dimension (vertical line) represents activated or deactivated mode. In order to differentiate user's affection state towards a product, these two dimensions could be combined to

show either positive affect or negative affect depending upon which quarter in the core affect circle the user's state resides.

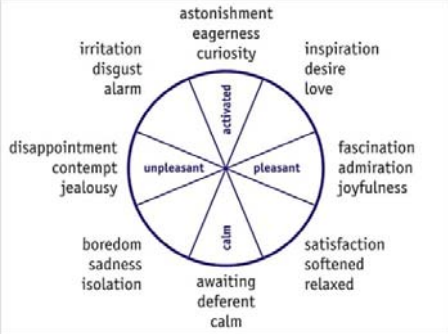


Figure 1: Core affect theory.
(Source: adapted from Russell, 2003; Desmet, 2007)

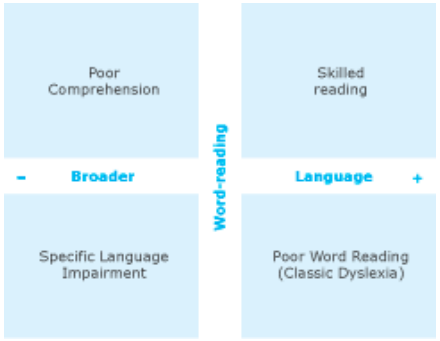


Figure 2: Reading model (Wright, 2010)

To ensure that the DC using ART reach the positive affect state, the ART is specifically designed by incorporating the children's affective characteristics towards reading as suggested by Fakhrul, Husniza, and Zulikha (2010). For that, affective engineering is used to elicit requirements that can create pleasure and activation to achieve the above two positive dimensions as shown in the core affect theory illustrated in Figure 1.

AFFECTION IN READING

The children's positive affect can be directly spotted when they are interacting with computer-based applications. However it can only be easy with a proper design of interaction in the application's user interface. Designing such interaction had always been far from perfect especially for DC due to the variability in their reading patterns. Figure 2 shows a model of reading which classify poor word reading as classic dyslexia. According to Wright, (2010) this model holds that reading is a function of one's ability to read the words (rw) on the page (p1…n) and the ability to apply linguistic (al) and reasoning skills (ar) to the decoded text, i.e. moving towards broader language skills in the model (*Reading = (rw) + skill (al + rs)).*

At word level, is there a way to bring in affective values into an ART? We believe that by incorporating instructional strategies into existing interaction model a more appropriate framework for effective ART can be obtained. Thus this work aimed at combining two well known interaction models namely Norman's Interaction Model and Abowd and Beal model. The models, supported by core affect theory will then be translated into interaction design (IxD) strategies in designing the user interface for an ART meant for DC.

THE INTERACTION MODELS

Norman's interaction model consists of a logical execution-evaluation cycle, mainly a method of conceptualizing the philosophy of computer interfaces. Figure 3 depicts the original Norman's model of interaction which breaks down the process of interaction between human and a computer-based application into seven phases. Beginning with forming the goal, an intention will be formed followed by specifying and executing action. After that, a user will perceive the state of the world, interpreting it and evaluating the outcome. Execution-evaluation loop will occur because users will take further action based on their evaluation.

Abowd and Beale (1991) expand Norman's model by giving a more realistic description of interaction. They include the system with its four major components namely User, Input, System, and Output (Figure 4).

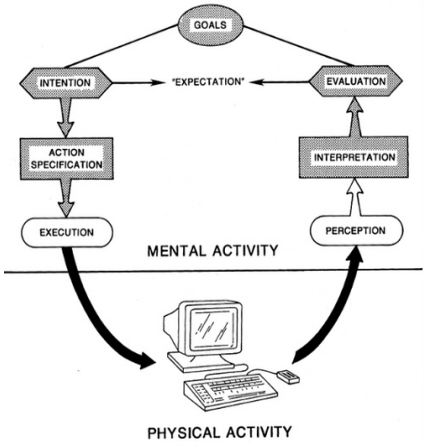


Figure 3: Norman's interaction model (Norman, 1986).

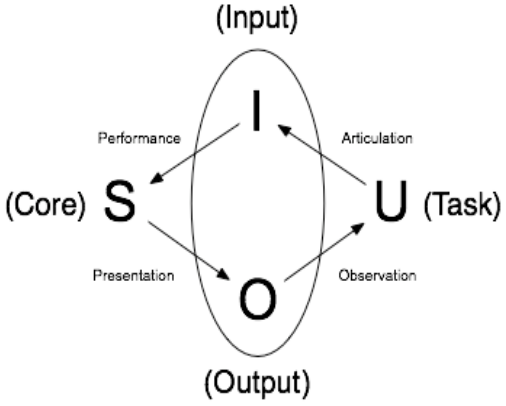


Figure 4: Abowd and Beale Model of interaction (Abowd & Beale, 1991).

Abowd and Beale (1991) indicated in their model the following interaction steps. The user communicates with the system via input/input devices (articulation). This is the process of describing request in the form of a language understandable by a task. The request is executed using a certain core language (performance) and then produce output to users in a presentation phase. The user may continue with observation on the results or start formulating new goals. Putting the interaction models into the DC's context, the interaction design should consider the impairments specifically the types of reading errors, fonts and colours. Embedding such design ensures that the ART is capable of giving maximum effect towards the performance of the children's reading. Effective interaction design of the ART's interface shall ease the dyslexic children (User) in reading aloud prompted words (Input) displayed on the screen. The read speech is then recognized (System) and the result is presented back to the user (Output). The children can observe the output i.e. the text produced and later decide what to do next (formulating new goal).

METHODS AND ANALYSIS OF STUDY

In Norman's model, the gap between physical and mental activity is actually the gap between 1) how the user want to act and how the system allows or support the users to take action; and 2) how the computer display its output and how the users interprets the output. To minimize the gap, the tasks in ART are supported by an IxD that addresses the DC's reading patterns, reading interactions and styles. The form, content, and behaviour dimensions of IxD are designed to reduce the cognitive load of the DC. The foundation of this design is based on the Abowd and Beale's interaction model.

In this context, we interviewed and observed 12 DC, aged between 7-14 years old, in an attempt to finalize goal decomposition and their reading task. The tasks are analyzed to an acceptable level, i.e. when the gap between physical and mental activity is eliminated. Focusing more directly on aspects that need to support the interaction of DC, each translation step in Abowd and Beale's model is examined so that affective characteristics and specific reading patterns can be mapped on to these translations. Figure 5 limns the model of the mapping and translation. Figure 6 shows the analysis on the children's impairment and the design results obtained after the observation and interview process. The figure is showing the analysis carried out in deciding the type of computer support, user interface screen objects, content, application behavior, and affective valence to be implemented in the ART. These are the types of IxD dimension and supports, obtained from the translation process from the DC's impairment (see column 3 and 4 in Figure 6):

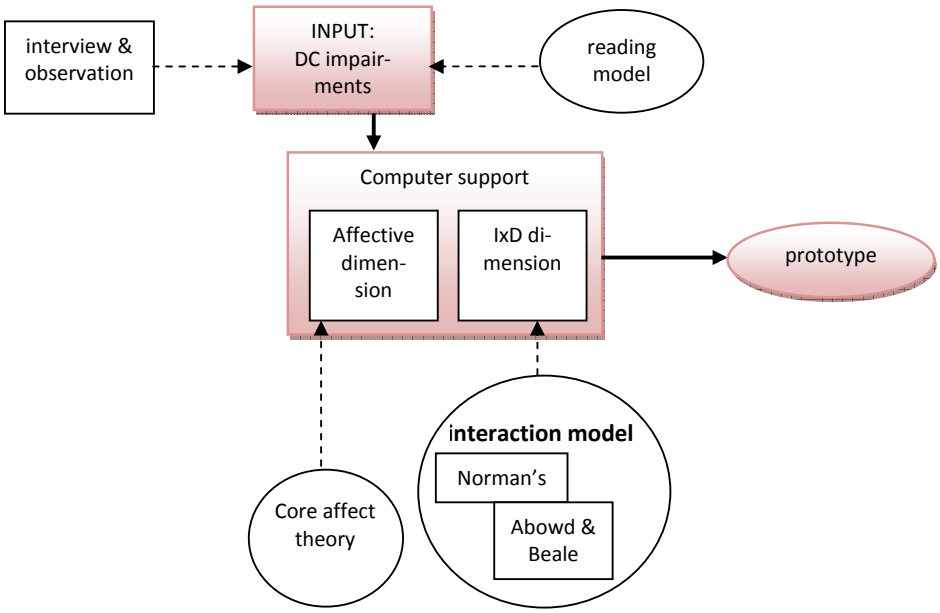
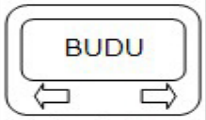
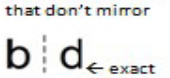


Figure 5: The IxD support model showing the mapping from Norman, Abowd and Beale interaction models.

- *Navigation* path is designed to overcome the problem of weak focus for coherence (or easily distracted) with minimum interface widgets (minimalist design), yet includes affective dimension of curiosity and relaxed.
- *Pen animation* that illustrates how to write an alphabet is proposed in order to support the limited cognitive load of dyslexic children. It has been observed that these children cannot handle reading a word due to the need for bigger cognitive load to accomplish the task. Therefore in order to read a word, the alphabet should be slowly crafted not just to illustrate the shape of the letter for easier identification but also for knowing the direction from where to start reading (as oppose to flash cards method). Affective dimension considered are curiosity, awaiting, and eagerness and the IxD dimension includes the level of words, the pen size, and the animation speed.
- *Coloured syllables* is used based on the fact that DC are highly affected by words and coloured background (Irlen, 2005). Hence, colours as suggested by Irlen are used for the background which can be changed easily by the children. The coloured syllables are based on the children's choice during interview and observation (the children are advised to choose their preferred syllable colours during reading exercise)
- *Fonts* and *typeface* handling are based on the observed reading errors made by the children. The most apparent reading pattern is they tend to substitute, eliminate or replace an alphabet with other alphabet. This suggests to a design of the similarly looking alphabet such as b and d not to mirror each other. Thus, the use of different typeface with different contrast is used to avoid the confusion. The children also have control over the type of fonts and choices of similarly looking words that they feel easier to read (and read them correctly!). Affective dimension included in such design are satisfaction and curiosity.

Using all 7 phases of Norman's Model and 4 components of Abowd and Beale.

Major* impairments (dyslexic children observed & interviewed)	**Computer support**	**IxD Dimension**	**Affective dimension to include**	**Design example (result)**
Easily distracted (weak focus for coherence)	- Limits distraction by simple interface design	**Form (F)**: large & minimum screen objects **Content (C)**: words to read **Bahaviour (B)**: - Choices for: 1. Word level 2. Number of words to display	- curiosity - relaxed	 simple navigation
Cannot take cognitive load	- Animation - Following the sequence while writing the word is easier than reading the word prompted as in the flash card.	**F**: writing animation **C**:words to read **B**: choices for: 1. Word level 2. Pen size 3. Speed of animation	- curiosity (have to wait, digest each alphabet...) - awaiting - eagerness	 pen animation
Very much effected with coloured words and background	- Utilize colour as adviced by Irlen Method for background colour - colour coded syllable	**F**: working with effective colours **C**:words to read, colour **B**: choices for: 1. Colour selection (background) 2. Syallabe 1st colour, 2nd colour is automatics from IxD theory of colour)	- joyfulness - astonishment - curiosity - fascination	**bunga** different coloured syallable
Alphabet confusion (consonant, vowel). Tends to substitute, eliminate, replace with other alphabets. e.g: b,d,p u,n,m,w Excellent with very different letters like k,t,g,s ... mostly consonant.	- Use carefully selected font type that don't mirror 	**F**: layout, contrast, usage of white space **C**:words to read, colour **B**: choices for: 1. Font types  2. Similar word selection	- satisfaction - curiosity	**badai** doesn't mirror b, and high contrast

*their minor impairments are not included in this paper due to page limitation

Figure 6: The analysis on the children's impairment and the design results obtained.

Figure 7: One of the screen interface of the ART.

CONCLUSION

A specific design of an ART is viewed important to cater for the children's needs – the need to have a carefully designed ART not only focusing on the reading tutor's engine but also the interface of such application. The interface design plays an important role to bring about the children's affection towards reading as well as the learning process. Special consideration on their need to have a suitable and adjustable background colours, different coloured fonts to highlight syllable boundaries in a word, as well as adjustable font types and sizes, for

example, would ease the learning process. Hence, the proposed model that combines two interaction models, Norman's and Abowd and Beale's models, caters for the need to 1) present the content or objective of an ART that meets the learners' goal, intention, and expectation; 2) ensure that the learning process is effectively delivered when the learners use the ART. Therefore, affective qualities, such as satisfaction, joyfulness, relaxation, and fascination, that satisfy the IxD dimension for dyslexic children need to be incorporated into the design of an ART. This proposed IxD model and interface design needs further study and an evaluation process is being carried out. It is not yet to be claimed as a pedagogically sound design that results in more effective reading tutor design for the special education context.

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