Text Entry for People with Mild Cognitive Impairments

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Abstract

Augmentative and Alternative Communication technologies have largely focussed on people with severe motor impairments or people who cannot speak. In this position paper we wish to discuss how text entry can better support people with mild cognitive impairments, what contexts text entry matters for them and how studies could take their needs into account.

Author Keywords

Text entry; assistive technology; cognitive impairment

ACM Classification Keywords

K.4.2 Social Issues: Assistive technologies for persons with disabilities

Introduction

The field of text entry for persons with intellectual disabilities has been under researched in recent years compared to that of other vulnerable groups such as visually impaired users (e.g. [2][9,12]). Many recommendations for making technologies accessible to people with learning disabilities focus on the utilisation of easy read methods. For example, proloquo2go allows the user to select options consisting of a combination of images and simplified text in order to formulate a sentence [11]. The selected options are then played back to ensure the needs of the individual are made known.

Williams and Henig found a potential issue with this approach when exploring the accessibility of online content [13]. They found that a considerable number of participants would either have difficulty understanding the meaning conveyed by the embedded images or would interpret them in different manners. As such, those participants with a greater understanding of language relied upon the accompanying text to navigate through the interface. This highlights the need to develop such resources in conjunction with the views of target stakeholders to ensure they are understood as intended and have the desired effect.

Furthermore, the inclusion of images results in longer pages that may require scrolling to view all the content available. People with learning disabilities have an increased chance of living in a home seriously affected by poverty [3] and may therefore suffer from digital exclusion. Consequently, this population may be unfamiliar with technologically specific actions such as scrolling or pinching- as highlighted by Williams and Henig who found that some participants were unaware that "invisible" content existed.

People with learning disabilities are highly heterogeneous in nature and often have additional impairments that affect aspects such as their linguistic and motor abilities [1]. Significant research has been conducted into text entry techniques for people with poor fine-motor skills. Polacek et al. [8] has conducted an extensive overview of the common techniques used by this population including: selection of keys, approaches to character layouts, use of language models, and interaction modalities. The authors found 61 distinct text entry methods over the past 30 years and evaluated these against a set of measurables ranging from the target group to the selection techniques, language models and modalities used.

Selection techniques were grouped into 3 categories. "Direct Selection" involves the user choosing a particular key from a limited set and typically includes three techniques for reducing the length of such sets: chording keyboards, ambiguous keyboards, and encoding. Ambiguous keyboards are the most commonly used technique with this population and involves grouping letters of the alphabet into one key. Multiple taps are then required to select the desired character.

Reducing the number of keys improves access for people with motor control difficulties but often comes at a cost of increased cognitive load and decreased entry speed. A former chief executive of a learning disability charity, interviewed by Gibson et al. [10], also suggested that people with short attention spans may have difficulty completing tasks that contain additional steps: *"Again it would depend on how easy they were to use but the quicker the better I would say. The shorter the better in terms of how much time someone would have to [complete it]. So easy to use absolutely…as few kinds of steps in the process, as few clicks in the process as possible."*

"Scanning" is used when a very low number of keys are available to the user (typically one or two). The technique typically includes a sequential highlighting algorithm that presents options to the user until the desired item is selected, in this case a character or group of characters. "Row-column" scanning is one of the simplest techniques used in which potential items are organised within a matrix. The algorithm will sequentially highlight the rows first until a selection has been made before the items in the selected row are linearly scanned. More complex scanning techniques have been described in depth by Polacek et al. [8], e.g. scanning ambiguous keyboards [5]. Scanning solutions tend to be focussed on people with very limited motion as they are particularly slow input techniques, for people with learning difficulties they could also cause interaction problems as short-term memory may be stressed by the slow nature of the input.

"Pointing and gestures" involves using non-traditional methods to select options, such as pointing devices controlled by trackballs, joysticks, head tracking, eye-gazing software etc. Some of these solutions, however, do not support direct selection e.g. eye-gazing. 3 common techniques are used to overcome this issue. "Dwell-time" supports selection when the cursor rests within a predefined radius for a select period of time. "Multimodal Interaction" involves the use of various modalities to confirm a selection. This may include actions such as head movements, speech recognition, non-verbal vocal commands etc. "Gestural input" involves the transformation of strokes, made via the pointing device, into text or through dynamic interaction (e.g. [9]). While necessary for those with learning difficulties who cannot use touchscreens or physical keyboards these are not suitable for others.

Character layout involves detecting the optimal layout of characters, or sequences of characters, used to maximize the stakeholders type rate. They may generally be divided into two categories: static and dynamic. During static distributions (distributions meaning the sequence of operations required to type a character) the sequence of operations required to enter text remain consistent throughout. In comparison, dynamic distributions alter the sequence of actions required to enter text depending on the current context – for example altering the sequence of letters on each key based on the current written context. This may be cognitively demanding for people with learning disabilities - a population that often requires a consistent and predictable approach to communicating or navigating across user interfaces, as discussed by one of the experts interviewed by Gibson et al., [10]; *"I suppose that good practice would say you should always take a consistent approach to your communication style with people [who have learning disabilities]."*

Language models are the final techniques characterised by Polacek et al. [8] and are a means of characterising language in a structured and consistent way. Almost all text entry methods use a language model as a means of predicting the intended input of the user. 3 essential approaches were discovered by the authors: syntactic, semantic and statistical. Syntactic and semantic approaches store rules either in probability tables or as a grammar and the difference between the two lies in the categorisation of words (syntactic or semantic categorization). The statistical approach predicts input based on historical statistics of usage, typically as word or letter n-grams. The order of the model further refers to the longest n-gram contained in the language model and the probability of the next items is extracted from the model based on already written n - 1 items. People with mild learning difficulties tend to have reduced vocabulary and may have difficulties with spelling and grammatical construction. Targeted language models may considerably help input but would lead to interaction style challenges such as: inexperience in using modern touchscreen interaction modalities; and the potentially excessive cognitive load placed on stakeholders due to word corrections/suggestions.

The work by Polacek et al. [8] is certainly a starting point for exploring text entry methods for people with learning disabilities. The paper highlights the various techniques used in existing resources and discusses how these affect people with significant motor impairments (a condition prevalent throughout the learning disability population). It would be interesting to discuss further how these techniques may be adapted to suit the complex needs of people with learning disabilities, particularly how they may address the cognitive deficiencies present throughout.

Another solution is to borrow from the field of AAC. Traditionally AAC and Text Entry have largely been considered as separate fields, however as pointed by [14] AAC and Text Entry share the goal of improving the communication experience of users. Fried-Olsen et al. [15] argue that AAC have a great potential to help users with neurodegenerative diseases. The great computational power available today and the affordability of smart devices could lead to Text Entry/AAC systems which could adapt to both stable and declining cognitive impairments.
Finally Norman and Alm [16] show the promise of AAC systems to help those affected by dementia.

Distinct text entry needs of people with cognitive impairments

In this position paper we wish to discuss:

- how text entry can better support people with mild cognitive impairments,
- what contexts text entry matters for them,
- and how studies could take their needs into account.

In particular mild cognitive impairments can lead to slow entry rates, forgetting the context of messages, reduced social awareness/empathy and difficulty in remembering words.

Cognitive impairments are also often tied with other impediments to fluid text entry such as reduced vision and motor control difficulties (e.g. post stroke). How do these co-limiters impact? In particular short term memory reductions could seriously impact the ability to use slow text input methods or exploit autocorrect suggestions.

Text entry study formats also need adjusted for people with mild learning difficulties. Copy tasks may overly challenge short-term memory limitations while composition tasks may be difficult on topics that the participants are not comfortable with.

Finally, can we develop general purpose text entry methods that (semi-)automatically adapt to the individual abilities and restrictions of users?

Biographies

Ryan Gibson has just completed his MPhil on support for people with cognitive impairments in preparation for medical appointments [10]. He has now started a PhD between the Digital Health & Wellbeing and Data Analytics & Mobile Interaction groups at Strathclyde.

Gennaro Imperatore recently completed his PhD on generative AAC for people with speech production problems as an after effect of a stroke [4].

Majed Al Khan is conducting a PhD on supporting navigation and independent movement of people with Down's Syndrome using smarter mobile and wearable technologies.

Mark Dunlop is a senior lecturer and leads Data Analytics & Mobile Interaction groups at Strathclyde. He has a long history of research in mobile text entry, conducted studies with older adults (e.g. [6]) and investigated support apps for stroke survivors [7].

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