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Drug name confusion: evaluating the effectiveness of capital (''Tall Man'') letters using eye movement data

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Abstract

Medication errors commonly involve confusion between drug names that look or sound alike. One possible method of reducing these errors is to print sections of the names in ''Tall Man'' (capital) letters, in order to emphasise differences between similar products. This paper reports an eye-tracking experiment that evaluates this strategy. Participants had their eye movements monitored while they searched for a target product amongst an array of product packs. The target pack was replaced by a similar distractor in the array. Participants made fewer errors when the appearance of the names had been altered, that is, they were less likely to incorrectly identify a distractor as the target drug. This result was reflected in the eye movement data.

Keywords: Medication error; Drug labelling; Look-alike names; Eye movements; Tall Man letters; Patient safety

Introduction

Medication errors may involve the wrong drug, wrong dose, wrong patient, wrong route of administration or the wrong time (Cohen, 1999). Recent figures suggest that confusion caused by drug names that look or sound alike accounts for between approximately 8% (Flynn, Barker, & Carnaham, 2003) and 25% (see e.g., Hoffman & Proulx, 2003) of errors. Drug nomenclature falls into two categories: proprietary (i.e., brand) and non-proprietary (i.e., generic). Brand names may be similar so that the value invested in one trademark can be transferred to another. Generic names must be meaningful to healthcare professionals, resulting in drugs that share a mechanism of action or chemical constituent often intentionally being given the same prefix or suffix.

Strategies for reducing name confusion errors must consider both preventing the approval of new names that may be confused with existing names, and dealing with existing confusable names. Lambert and colleagues (e.g., Lambert, Lin, Chang, & Gandhi, 1999) have investigated objective methods to screen proposed names for similarity with existing names. There is currently little empirical research on potential methods of preventing confusion errors caused by existing names. One such method is to alter the appearance of names on computer screens, shelf labels, product labels, etc. to emphasise the differences between similar names. For instance, Cohen (1999) suggests that it is easier to differentiate ''DOBUTamine'' and ''DOPamine'' than ''dobutamine'' and ''dopamine''. The US Food and Drug Administration (FDA) Name Differentiation Project implemented this idea in 2001. Following FDA recommendations, The Office of Generic Drugs requested that manufacturers of 16 look-alike name pairs voluntarily revise the appearance of established names. Manufacturers were encouraged to produce labelling that visually differentiated names using 'Tall Man'

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(capital) letters and perhaps also colour (see http://www.fda.gov/cder/drug/MedErrors/nameDiff.htm for the recommended revisions).

Previous studies have suggested that Tall Man letters can make similar names easier to distinguish in a same-different judgement task (Filik, Gale, Purdy, & Gerrett, 2003), and can improve recognition memory by increasing attention (Filik, Purdy, Gale, & Gerrett, 2003). The current study was designed to be analogous to a real life situation in which someone has seen a drug product, committed it to memory, and then searched for it amongst an array of products on a shelf, some of which may have similar names to the target product. It was hypothesised that if Tall Man letters make similar names less confusable then participants should be less likely to indicate that a target product was present in an array, when in fact it was a product with a similar name that was present, when the name contains Tall Man letters.

Participants' eye movements were recorded during the experiment in order to evaluate eye-tracking as a means of investigating medication errors involving drug package design. Eye movement data are commonly used to investigate visual search, and in reading research as a measure of processing difficulty (see Rayner, 1998, for an overview), so may well reflect the difficulty that participants experience with similar looking drug names.

Method

Participants

Twenty staff and students (non-healthcare professionals) from The University of Derby, who had either obtained or were studying for a university degree, participated.

Materials

Mock drug packs (see Fig. 1) were designed, on which information was limited to the generic name, dosage form (e.g., tablets) and the strength (e.g., 100 mg) in Arial font (as packs are commonly printed in sans serif fonts). Packs were made to look three dimensional, had a coloured band down the left-hand side and the words "Patient Pack 28" along the bottom.[1]

Drug information was selected from the Nurses PDR Resource Center database (http://www.nursespdr.com/). Clinically available dosage forms and strengths were adhered to whenever possible, but were occasionally

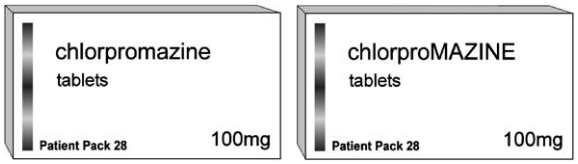

Fig. 1. Example target packs: one with the name printed in lowercase, and one containing Tall Man letters.

altered so that similar pairs of drugs had identical dosage forms/strengths and differed only in the name. Materials were 20 pairs of drugs with similar names, 16 of which were from the FDA Name Differentiation Project. The remaining four were selected from the database.

One drug from each pair was presented as a target to search for (e.g., chlorpromazine), and the other drug was present in the array as a distractor (e.g., chlorpropamide). Hence, it is critical to note that the target was never present in the array. The array consisted of the distractor plus 19 other drug products. These 19 items were selected from the database, and screened for low similarity with the target drug using an objective measure of similarity (outlined in Lambert, Chang, & Lin, 2001). Half of the drugs had names in lowercase, and half contained Tall Man letters. The array was four packs across and five packs deep (see Fig. 2). Each individual pack subtended 7.30° of visual angle horizontally and 4.10° vertically, and packs were separated by gaps of 1.46° to the participant. Distractors appeared once in each of the 20 positions.

To prevent participants from noticing the target was never present in the array, 20 filler trials were added in which the target *was* present. There were also 80 additional trials from an unrelated experiment investigating strength confusion. Trials were presented in a random order. There were two different stimulus files so that all names were presented in both forms, but no participant saw each name more than once.

The software to run the experiment and record both error and search time data was developed in Microsoft Visual Basic (v 6.0). Stimuli were displayed 615 mm from participants' eyes on a 21-in Sony FD Trinitron Model GDM F520 flat screen colour monitor, with a resolution of 1600 × 1200 pixels and 32-bit colour depth. An Applied Science Laboratories (ASL) 504 remote eye-tracking system discreetly monitored participants' eye movements as they performed the task. The eye-tracker delivered point of gaze as a set of coordinates every 20 ms, with an accuracy of 0.5° of visual angle and a resolution of 0.25°. Search time was recorded using two buttons, which were connected to a parallel port of the computer and independently tested for millisecond accuracy.

[1] For a description of all elements that are required to appear on drug labelling, see article 54 of Directive 2001/83/EEC of the European Parliament and Council of 6 November 2001 on the Community code relating to medicinal products for human use.

Fig. 2. Example array in which the participant must search for the target pack. In this array, the distractor is 'chlorpropamide', with the target to search for being 'chlorpromazine'.

Design

The independent variable was whether or not the names contained Tall Man letters. There were four dependent variables: the number of errors (e.g., participants indicating that a pack was present in the array when it was not); search time (time taken to make this decision); total time spent fixating the distractor pack in the array, and the total number of eye fixations on the distractor.

Procedure

Participants were given written instructions describing the task. They were asked for their consent, assured that their data would be kept confidential, and informed of their right to withdraw. The eye movement system was then calibrated. Participants' head movements were limited using a chin rest. Participants were first presented with a target pack to memorise. They could view the target for as long as they needed, before pressing a button to continue. The target was replaced by a pattern mask, which remained on the screen for 0.5 s before being replaced by a fixation cross appearing in a random location on the screen (for 1.5 s). Participants were then shown an array of packs and had to indicate whether the target was present or absent by pressing one of two buttons, marked "Y" and "N" (see Fig. 3 for an outline of the procedure).

Participants were instructed to respond as quickly and as accurately as possible. The experiment took between 30 and 60 min, after which participants were debriefed.

Results

ASL EYENAL (v 5.44) analysis software was used to process the information recorded by the eye-tracker. Raw eye position data were reduced to a series of fixation points, identifying fixations (a person's point-of-regard as he/she looks at a stationary target in a visual field), and saccades (rapid voluntary eye movements

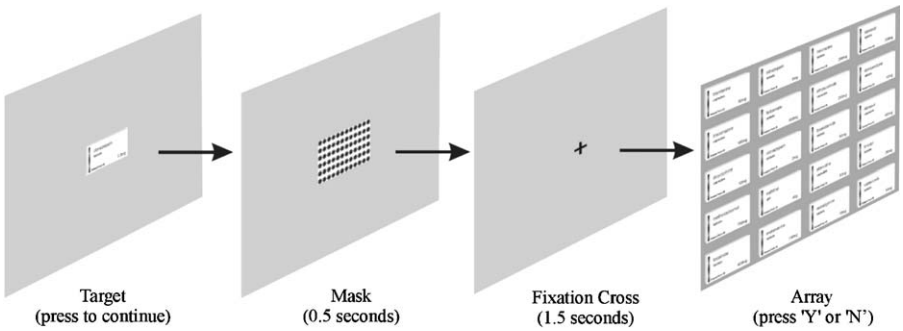

Fig. 3. Diagram illustrating the experimental sequence, showing the target, mask, fixation cross, and array.

used to move from one fixation point to another). A fixation was defined as the mean X and Y eye position coordinates measured over a minimum period of 100 ms during which the eye did not move more than about 1°. Analysis regions were created by dividing the array into 20 equal-sized areas, each comprising one pack and half of the space between adjacent packs. The fixation data were matched with the analysis regions and used to calculate the mean number of fixations and the total fixation duration on the region containing the distractor pack.

Two repeated measures *t*-tests were conducted on each of the following measures: the number of errors; search time; total fixation time on the distractor pack, and total number of fixations on the distractor. One *t*-test treated participants as random variables ($t1$) and one *t*-test treated items as random variables ($t2$). Participants made more errors (i.e., they incorrectly reported that the target pack was present in the array), if the name was in lowercase (7.75%) than if it contained Tall Man letters (3.00%), $t1 = 3.57$, df = 19, $p < 0.005$; $t2 = 2.54$, df = 19, $p < 0.05$. There was no difference in search time across the lowercase (9.82 s, s.d. 2.47) and Tall Man (10.11 s, s.d. 2.78) conditions, $t1 = 0.67$, df = 19, ns; $t2 = 0.79$, df = 19, ns. The total time spent fixating the distractor pack was longer for packs with lowercase names (1.90 s, s.d. 0.80) than with Tall Man names (1.42 s, s.d. 0.45 s), $t1 = 3.74$, df = 19, $p < 0.005$; $t2 = 3.31$, df = 19, $p < 0.005$. Participants also made a greater number of fixations on the distractor pack when the name was in lowercase letters (5.6 fixations, s.d. 2.12) than containing Tall Man letters (4.6 fixations, s.d. 1.42), $t1 = 2.76$, df = 19, $p < 0.05$; $t2 = 2.69$, df = 19, $p < 0.05$.

Discussion

Participants were less likely to incorrectly indicate that a target drug was present in an array when the name contained Tall Man letters. This kind of error corresponds to a medication error in which the wrong product was selected from a shelf. Importantly, the eye movement data directly corresponded with the error data: in conditions where participants made more errors, they also made more fixations and spent longer fixating the relevant portions of the array. This indicates that eye movements may be sensitive to factors that lead to errors being made, and may therefore be a useful tool for investigating error in this context.

There are a number of limitations to the current research. Participants were not healthcare professionals. It is therefore possible that these results may not generalise to people who are more familiar with drug names. However, errors are made by both healthcare professionals and patients, and previous research into look-alike names has found the same pattern of results for pharmacists and college students (Lambert et al., 2001). The current study examined name confusion error in a controlled laboratory environment, necessarily excluding other influences, such as workload and stress (see Reilly, Grasha, & Schafer, 2002). Errors in real life generally result from the interaction of several factors. Stimulus materials contained less information than real packs, and only generic names were examined.

It is widely acknowledged that medication errors occur as a result of unsafe systems. This study has demonstrated the utility of the use of Tall Man letters as a possible systems change that could be made by both pharmacies (on medication labels, shelf labels) and manufacturers (on medication packages and labels, computer software) in an effort to reduce error caused by drug name confusion.

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