AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

Evaluating the Effect of the Australian List of Tall Man Names

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Executive summary

Medicine name confusion has been identified as the cause of numerous medication errors in Australia and internationally. The major determinant of medicine name confusability is the degree of similarity between the confused medicine names. Tall Man lettering is a typographic technique that uses selective capitalisation to help make similar looking medicine names more easily differentiable. In order to assist the health system in adopting Tall Man lettering, reduce the variation in Tall Man lettering used in Australia and to maximise the benefits of Tall Man lettering, the Australian Commission on Safety and Quality in Health Care developed a standard list of Tall Man names for the Australian context.

As part of the development of national list of Tall Man names, the Australian Commission on Safety and Quality in Health Care commissioned a study assessing the effect of Tall Man lettering on the confusability of medicines names. Specifically, the study was to determine whether Tall Man lettering increased the rate of error.

A laboratory-based experiment to evaluate the effectiveness of Tall Man lettering was constructed with reference to previous experiments on Tall Man lettering and the broader subject area of cognitive psychology. The experiment tested the rates of errors made in identifying medicine names presented in one of three formats:

- natural case
- Mid Tall Man (as per the standard list compiled by the Commission)
- random capitalisation.

The experiment also recorded the time taken to provide a response.

Over the first half of 2011, 29 junior medical officers (interns and resident medical officers) and 35 registered pharmacists participated in the experiments.

Data collected from junior medical officers showed considerable variability and provided no significant evidence for a benefit of any of the three conditions tested over any other condition. The only conclusion drawn from the junior medical officer data was that they performed the task more slowly and more inaccurately than pharmacists.

Pharmacists performed accurately in all conditions, with no significant difference found in the number of errors made with any one type format. Measurement of reaction times demonstrated that both Mid Tall Man and natural case were responded to significantly faster than random capitalisation. There was no significant difference in the rates of response to Mid Tall Man and natural case.

The data supports the use of a standard format for Tall Man lettering and does not indicate that application of Tall Man lettering, as proposed by the Australian Commission on Safety and Quality in Health Care, will lead to any increase in medication errors.

1. Introduction

The potential for medicine name similarity to cause medication errors is recognised by healthcare professionals [1], pharmaceutical manufacturers [2], safety agencies [3], professional indemnity insurers [4] and regulators alike. In the late 1960s, Benjamin Teplitsky commenced an awareness raising campaign, writing to a number of significant medical journals warning clinicians of risks associated with medicine name similarity [5]. In 1992 he, together with Davis and Cohen, published a list of 645 confusable medicine name pairs in an effort to capture the attention of regulators and start the process of designing safer names [3]. Concern was also raised by Aronson [6] about the potential confusion caused by the practices related to the naming of over the counter medicines in the United Kingdom.

The literature is awash with specific cases and examples of medicine name confusion, many of which have caused significant patient harm [7-9]. Recent work undertaken in Australia has detected at least 182 pairs of Australian medicine names that have been identified as confusable (unpublished work of Rizk & Emmerton).

In the Australian Council for Safety and Quality in Healthcare's second national report on patient safety[10], the existence of medication names that sound or look alike and medication packaging and labelling that can easily cause confusion were cited as two system issues contributing to medication errors. Since the release of this report, some activity has taken place at a national level to address the risks associated with look alike, sound alike medicines, including a push to incorporate the use of technology, such as bar-code scanners, in medicines handling processes.

A small amount of research has been done on the application of graphic design principles in order to increase contrast between similar medicine names[13-15]. Researchers have explored the effects of using different fonts, colours, text size and the capitalisation technique known as Tall Man lettering[15]. To date, this small number of studies indicates that Tall Man lettering is the most effective graphic technique tested thus far. However, the work of Filik et al. appears to show that the technique is effective only when the purpose of the Tall Man lettering is known by the subject[14]. At worst, the research indicates that Tall Man lettering works as a flag to clinicians, identifying products as being at risk of name confusion and associated errors.

The Australian Commission on Safety and Quality in Health Care has derived an Australian list of Tall Man names based on two assumptions, that:

- Tall Man lettering can help to reduce confusion between similar medicine names
- through creating a nationally standard list of Tall Man names, the technique can be more easily applied and will have the greatest impact.

This research has been commissioned to determine whether, in a computer based experiment, Tall Man lettering is detrimental to the perception of medicines names.

2. Previous studies

To date, there has been belief amongst some healthcare professionals and most safety agencies that Tall Man lettering is of benefit in reducing look-alike, sound-alike errors but the academic evidence to support this belief has been varied and inconclusive.

Early research on the effectiveness of Tall Man lettering was conducted by Filik and colleagues in 2003 and 2004[11] where they showed a small positive effect for Tall Man lettering in a same-different task, and in identifying medication in digital representations of medicines packaging. The key findings from the same-different task were reported in 2006[12] with potentially the most important being that Tall Man lettering performed better in reducing errors only when the subject understood that the capitalisation was designed to reduce error. In same-different studies, the time taken to make a decision as to whether the two presented medicine names were the same or different (reaction time) was used as a marker of the effectiveness of Tall Man lettering in reducing similarity.

Gabriele conducted a small study published in 2006 (n=11)[13]. In this study nurses were provided a list of 7 medicines names presented in one of several formats including Tall Man. They were subsequently given another list of medicines that contained some items from the original list and some which were not on the original list but were similar to those that were (the distractors). Participants subsequently stated for each item on the list whether they were or were not on the original list. This experiment found no difference between error rate with Tall Man and normal case.

In 2009, Schell reported on studies that used a "go/no-go" test[14]. In this study, Schell showed that neither Tall Man lettering nor text enhancement using colour was effective in reducing confusion between similar medicines names. The study found no difference between conditions in the incorrect identification of two names as the same when they were different (false-negatives). Results showed that Tall Man lettering caused an increase in 'false-positive' responses, where participants identified a medicine name as being different from the target name when it was actually the same. These findings were, at least partially, contradicted by Filik et al. in 2010 when they applied Schell's go / no-go test in non-healthcare professionals[15]. Filik et al. reported a reduced number of false-negatives in the Tall Man condition, finding that Tall Man decreased similarity and confusability.

Darker et al. used a different study design from previous research, adopting the Reicher-Wheeler task[16]. This test presents a target word and then two alternate choices, one of which is the target word and the other a distracter. The task is to select the target word. Importantly, the task is conducted at each participant's limit of perception, with screen contrast and other conditions automatically altered during a 'calibration' phase in order to achieve errors at or around a pre-determined rate. Using this test, Darker et al. found Tall Man lettering to be effective in reducing confusion between similar medicine names and also

demonstrated that not all Tall Man names are equally effective. Moreover, they constructed several lists of Tall Man names in different formats (i.e. with different word sections capitalised) and showed that they did not have equal effectiveness in reducing error rates.

Importantly Gabriele[13], Schell[14] and Filik[15], Darker[16], Gerrett[17] et al. have conducted research into the effects of Tall Man amongst healthcare professionals. The use of healthcare professionals is important given the findings of Lambert showing that medicine name confusion is increased by both neighbourhood (how many similar names there are) and frequency effects (how familiar the subject is with a particular medicine name)[18]. Given the assumption that healthcare professionals will be far more familiar with particular medicine names than non-healthcare professionals, the effects of Tall Man may be markedly different between these groups. Additionally, in discussing their findings, Darker et al. suggest that there may be a variable performance between professional groups due to their differing experience and internal lexicons. There is currently no data available to suggest that this is or is not the case.

Despite the fact that Gabriele and Schell both tested Tall Man lettering with healthcare professionals, the findings from these studies are of limited value due to small sample sizes (11 professionals in each group).

Variability in previous studies

It is clear from the above discussion that there is considerable variability in the way researchers have attempted to evaluate the effectiveness of Tall Man lettering. In the small number of studies published, at least six different experimental designs have been used. Schell's go/no-go methodology was used by Filik et al. in their 2010 study, providing the only case where independent verification of results could be shown. However, the findings of these two studies were not in agreement. Additionally, there has been a mixture of participants including healthcare professionals and non-healthcare professionals as well as differences in the specialities and qualifications of healthcare professionals tested. There has been no consistency in the format of the Tall Man names tested with names being derived from a number of sources including the United States Food and Drug Administration (FDA) name differentiation project, the United States Pharmacopoeia and the United Kingdom's National Patient Safety Agency.

The variability in findings may come as a result of variability in any of these areas (participants, specific experimental design or the Tall Man list tested).

Table 1: Summary of Previous Studies

Study	Task	Main conclusion	Study participants	Tall Man names used
Filik et al. 2006[12]	Same / Different	Tall Man effective only if participants are aware of its purpose	20 university students and staff (not healthcare professionals)	16/80 from the FDA name differentiation project, 64 developed for the testing
Filik et al. 2004[11]	Array search (digital package search)	Tall Man names on digital mock packages yielded fewer errors of selection, decreased search time and reduced the number of times participants fixated on distractor names compared with normal case	20 university students and staff (not healthcare professionals)	16/20 from FDA name differentiation project, 4 developed for the testing
Gabriele[13]	List recall	Conclusions limited due to sample size, but no evidence to show Tall Man any different from natural case, bolding less effective than natural or Tall Man	11 acute care nurses	FDA name differentiation project
Schell[14]	Go / No go	Tall Man ineffective in reducing error and increased the number of "false positives"	102 undergraduate university students (likely psychology students, although not explicitly stated) 11 pharmacists and pharmacy technicians (numbers of each not identified)	USP
Filik et al. 2010[15]	Go / No go List selection task	Tall Man was effective in reducing "false negatives" Tall Man provided a small but significant improvement over natural case	28 older adults, 28 younger adults – non-healthcare professionals 127 healthcare professionals comprising 48 general practitioners,16 community pharmacists, 18 community pharmacy technicians, 1 hospital doctor, 18 hospital pharmacists (1 pre-registration), 25 hospital pharmacy technicians and 1 medical student	NPSA determined list of confusable names (80 pairs) with CD3 rule applied
Darker et al. 2011[16]	Forced choice (Reicher-Wheeler)	Mid Man was effective in reducing error, not all Tall Man formats are equivalent	133 healthcare professionals comprising 52 medics, 36 pharmacists, and 45 pharmacy technicians,	NHS (NPSA) determined list in CD3 and Mid Tall Man and FDA name differentiation project, wild form Tall Man and uppercase

3. Experimental design

Hypotheses

The experiment was designed in order to answer a number of hypotheses, that:

- natural case causes fewer errors than Mid Tall Man lettering
- natural case causes fewer errors than names constructed with random capitalisation
- Mid Tall Man lettering causes fewer errors than names constructed with random capitalisation.

Ethics

Ethical review was conducted by the Ethical Review Panel of School of Psychology University of New South Wales (application number 1447) who recommended that approval be granted by the Deputy Vice Chancellor (Research). This approval was granted.

Lessons from previous studies

Experimental design and outcomes from previous research were used as a reference when constructing the task to be used in this experiment.

The following points were considered to be most relevant:

- The participants should be healthcare professionals, representing at a minimum the disciplines of pharmacy and medicine.
- The effects of Tall Man may vary due to participant effects or due to similarity effects of individual medicine names (i.e. the more similar a medicine pair, the more likely confusion will occur).
- It has been shown (twice) that 11 participants is an insufficient number to yield significant results.
- Significant results have been demonstrated with 20, non-healthcare professional participants.
- The error rate associated with Schell's experiment was low and it is thought that a ceiling effect of accuracy may have masked any real benefits or detriment of Tall Man lettering. The experimental design must be such that a sufficient number of errors are made to avoid a ceiling effect. An alternative approach would be to use a surrogate marker of effectiveness such as reaction time.

Participants for testing

Participants in the evaluation of the Australian Tall Man list were all currently practising healthcare professionals and included 35 pharmacists, a mixture of hospital and community pharmacists, and 29 junior medical officers.

Doctors and pharmacists were the main target groups for participation as they currently have the greatest interaction with electronic systems.

Location

In order to enrol as many participants as possible, research was conducted at large meetings. Junior medical officers were recruited at the NSW Clinical Education and Training Institute's Junior Medical Officer Forum and pharmacists were recruited at a weekend symposium of the Pharmaceutical Society of Australia, continuing education sessions of the Society of Hospital Pharmacists of Australia and prior to an education workshop held at Clinical Excellence Commission.

No particular effort was made to create quiet space as it was acknowledged that clinical practice often occurs in noisy environments with many distractions.

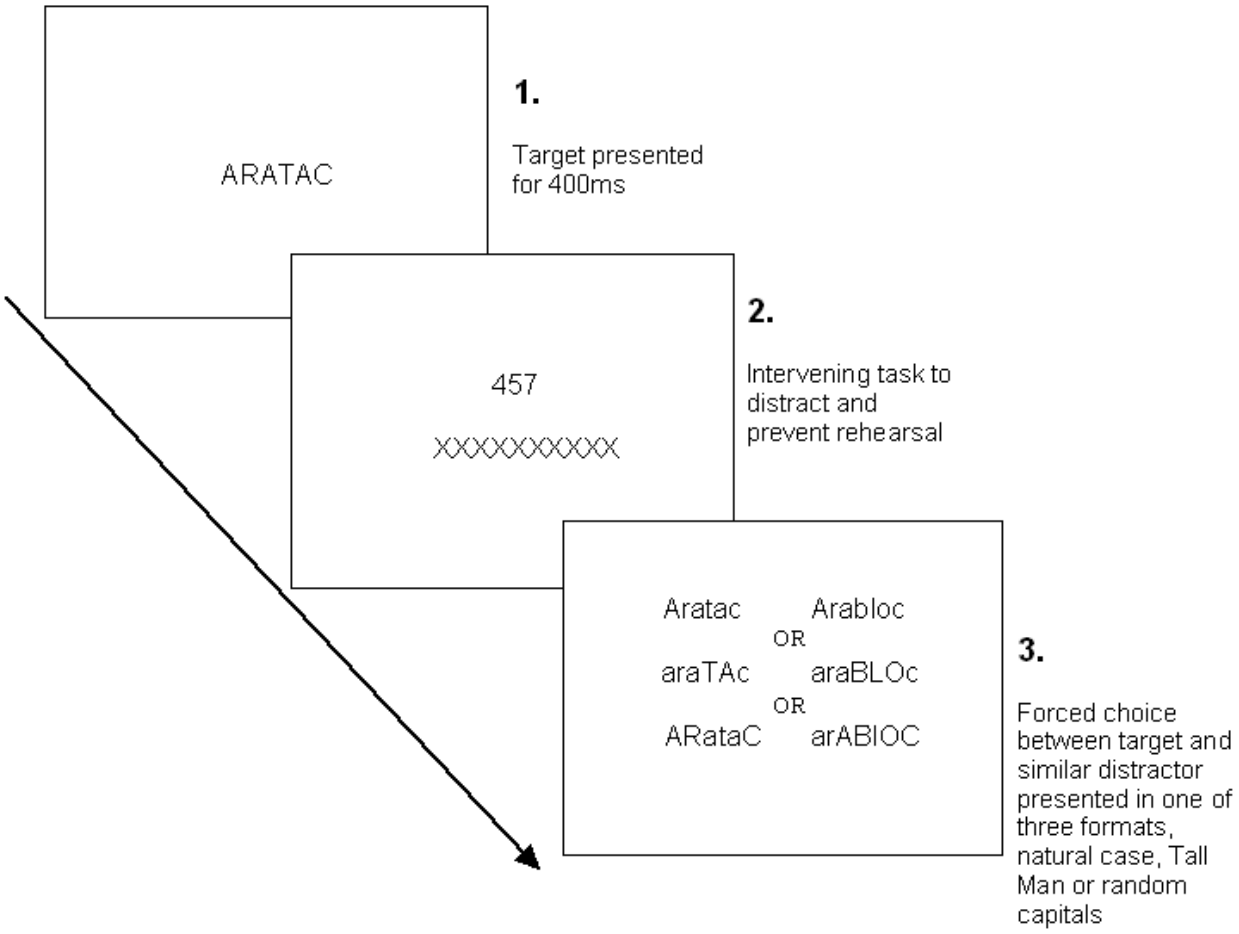
Task

Due to the necessity to conduct the testing in the field, eye-movement tracking as used by Filik et al. [11] was not possible. To maximise participation, the overall study design was such that each participant could be tested in less than ten minutes.

The following task was designed to determine the effects of Tall Man lettering on name confusion. Using identical lap-top computers and the psychology software DMDX (www.u.arizona.edu/~kforster/dmdx/dmdx.htm), participants were presented with a medicine name (the target) presented in all upper case for a total of 400 milliseconds (ms). This was automatically replaced with a row of Xs and a three digit number, randomly generated. The participants were asked to count backwards by threes from the number presented whilst the number was displayed (for a total of 3 seconds). This task was intended to prevent rehearsal of the target. Finally, the target and a similar medicine name (the distractor) were presented side by side and the participant was forced to choose between them, indicating which was the target (see figure 1.).

In the forced choice stage, the target and distractor appeared on the left and right of the screen an equal number of times so as to avoid bias caused by position.

Figure 1: Experimental Procedure



Stimulus

The experiment tested task performance when medicines names were presented in Mid Tall Man lettering, the accepted 'natural case' used in computer systems, and a non-systematic, random capitalisation format. Natural case for generic names was considered to be all lower case letters (e.g. morphine) and for brand names, lower case with an initial capital (e.g. Norvasc).

Ninety pairs of confusable medicine names were selected from the Australian list of Tall Man names compiled by the Australian Commission on Safety and Quality in Health Care. Names were excluded if they were exceptions to the Mid Tall Man rule. Additionally, where a group of more than two names is included in the Tall Man list (e.g. Aldomet, Aldactone, Alodorm), only one pair of names was used in the testing.

Each participant viewed all 90 pairs of confusable names, one third presented in natural case, one third presented in Mid Tall Man and one third presented in the random capital format. The stimuli were constructed in a Latin Square design, that is; three separate stimulus sets were constructed such that each name pair was presented in each of the three formats. Each participant was only presented each name pair once. A copy of the stimulus list can be seen in Appendix A.

Rationale for task and stimulus

This task design addressed a number of lessons learned from previous studies.

- Firstly, only healthcare professionals were enrolled as participants. This reduced bias related to the participants' internal medicine lexicons.
- The Latin Square design ensured that the confusability of each medicine pair is tested under each of the study conditions i.e. in each of the three typographic formats. This ensured that the degree of similarity within the name pairs was controlled between the three typographic conditions.
- A 400ms stimulus had previously been used by Schell and by Filik et al. with success in the go/no-go test.
- The intervening task (the count backwards task) was designed to increase the error rate by preventing rehearsal. A sufficient error rate was necessary to prevent ceiling effects and allow a comparison of error rates. A mathematical task was chosen as such a mental task may be required in prescribing or dispensing medicines.
- Reaction times were recorded as a surrogate of error rates. As reaction time increases, it is assumed that the difficulty of processing the information presented is also increasing.

Data analysis

Data was analysed using Analysis of Variance (ANOVA) to explore differences in both error rate and reaction time to names when presented in the three different formats. Performance was evaluated on both a by-item and a by-subject basis. By-item means gave the percent errors made in perceiving a particular medicine name in each of the formats (e.g. in junior medical officers the following error rates were associated with Actonel; natural case = 10% error, Mid Tall Man = 0% error, random capitalisation = 14% errors). By-subject means gave the percentage of errors made by a particular subject across all items in each of the three formats (e.g. subject G1S17 had a 4.2% error rate with natural case, 0% error rate with Mid Tall Man and a 3.6% error rate with random capitalisation).

Performance of pharmacists was compared to that of junior medical officers, and analyses were conducted for the overall experiment and separately for each of the two professional groups.

All statistical analyses were conducted at the 95% confidence level.

4. Results

Analysis of data related to error rates showed no significant difference between any of the three conditions when analysed by subject or by item. Error rates were significantly higher for junior medical officers (JMOs) than pharmacists in all conditions.

Table 2: Number of errors made in each text format (averaged by item)

	Natural case	Mid Tall Man	Random capitalisation
Pharmacists			
Mean error rate (%)	7.1	6.6	6.0
Standard deviation	(10.8)	(8.4)	(8.2)
JMOs			
Mean error rate (%)	17.9	16.5	18.4
Standard deviation	(16.8)	(17.5)	(17.4)

Analysis of reaction times for each of the text formats did, however, show significant results. Whilst no effect was seen in the JMO data, pharmacists responded significantly faster to natural case and Mid Tall Man than they did to random capitalisation. No significant difference was seen between the response rates to natural case and Mid Tall Man.

Table 3: Pharmacist reaction times to each format (averaged by item)

	Natural case	Mid Tall Man	Random capitalisation
Reaction time (ms)	1,013	1,031	1,071
Standard deviation	(132)	(118)	(112)

5. Discussion of results

The results of this experiment provide interesting data about risks associated with the use of Tall Man lettering and allow for a final recommendation to be made to the Australian Commission on Safety and Quality in Health Care. Primarily, the results demonstrate that, under experimental conditions, medicine names presented in Mid Tall Man format do not pose a greater risk of confusion than medicine names presented in natural case. Error rates appear slightly lower with Mid Tall Man format, but the variance in results is such that no significant effect can be detected.

Results collected in the two clinician groups were ultimately treated as separate data sets. The junior medical officers performed less accurately and more slowly than the pharmacists. It is likely that this would be explained by assessing the relative knowledge of medicine names between the two groups. It is assumed that pharmacists would have a greater familiarity with more medicines names, which would enhance the accuracy and speed with which they could perceive these names. The potential for this finding was flagged in the study design process, and was a main driver for recruiting both pharmacists and doctors. Having results from both populations enhances the quality of the findings of the study. However, the heterogeneity in the data collected from the two groups means that the results may be more meaningful when looked at for the specific clinician groups. A correlation analysis was conducted and determined that the same items were likely to cause problems in both pharmacists and doctors.

The most significant findings of the experiment are seen in the pharmacist reaction time data. Reaction time is regularly used as a surrogate of ease of perception and, in this context, it is hypothesised that a longer reaction time equates to increasing difficulty of perception. Darker et al. [16] have previously evaluated reaction time in experiments related to Tall Man lettering and reported that reaction times are greater for names in Tall Man format than for names in lower case. This finding is counter-intuitive and contrary to their error data collected in the same experiments. We have found that Mid Tall Man names did not significantly increase reaction time over natural case and had shorter reaction times than names in random capitalisation format.

Reaction time findings were significant as they showed that, within the experimental design, we were able to disrupt the perception of medicines names by presenting them in random capitalisation. Importantly, this disruption was not seen for Mid Tall Man names, further supporting the notion that names presented in this format will not contribute to medicine name confusion.

6. Conclusion

In conclusion, the findings of this experiment indicate that the use of Tall Man lettering, when presented in Mid Tall Man format, does not increase the risk of medicine name confusion amongst pharmacists or doctors. Reaction time data collected in the pharmacist group indicates that Mid Tall Man lettering is more easily perceived than names presented in random capitalisation.

The research supports the notion of a national standard list of Tall Man names.

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