Tall Man Lettering

Final Report

of

The Use of Tall Man Lettering to Minimise Selection Errors of Medicine Names in Computer Prescribing and Dispensing Systems

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Contents

Executive Summary

One source of potential error in prescribing is to mistake the required medicine name for another similar sounding or looking name. So called ‘look-alike, sound-alike’ medicine combinations are presented to Health Care Practitioners (HCPs) by computer-based prescribing and dispensing systems, and may predispose selection error. Approaches to try to prevent this happening include the use of ‘Tall Man’ lettering. This is where some letters of the medicine’s name, which is presented in lowercase font, possibly with the initial letter capitalised for a brand name, are capitalised. A literature search failed to identify any research on the impact of Tall Man in reducing medication error when electronic prescribing or medication ordering systems are used by HCPs.

The aim was to investigate whether using Tall Man lettering in electronic prescribing or medication ordering systems would be beneficial in reducing the possibility of error by the human misinterpretation of medicine names presented adjacently on a computer screen.

Previous research concerning Tall Man lettering was examined. This demonstrated that there was no universal agreement or rule-based approach to deriving Tall Man lettering formats for medicine names. Two consistent methodologies for deriving Tall Man naming conventions were developed. These were then examined in experimental studies alongside a third Tall Man naming convention, which was designed to reflect existing *ad-hoc* implementations of this technique. Currently-available electronic prescribing or medication ordering software systems in the UK were examined. None have implemented Tall Man lettering in their systems, although most had the technical capacity to do so.

Three experiments were then carried out with the following National Health Service employees as participants: General Medical Practitioners (GPs); hospital and community pharmacists; and, hospital and community pharmacy technicians. In the first experiment, the confusability of a medicine name with similar names was examined by presenting them in either a specific Tall Man variant (type CD3) or in lowercase font. It was found that the Tall Man variant led to a small significant increase in accuracy, while participants took slightly longer in selection (approximately 60 milliseconds). The second experiment examined basic perceptual processes in the recognition of medicine names where these were presented in three variants of Tall Man nomenclature as well as in capitals or lowercase. The use of either Tall Man or entirely uppercase text formatting was found to enhance medicine name perception over the level achievable with natural text formatting. Of the Tall Man variants, formatting medicine names according to the ‘Mid’ Tall Man rule offered the greatest advantage to perception. There were indications that Tall Man formatting could be further developed to confer greater advantages in the perception of a medicine’s name. Finally, a simulated medicine-selection task was developed based on the review of the available electronic prescribing and medication ordering systems. Participants were presented with medicine names in the three Tall Man variants, lower or capitalised case. No differences in error rates or response times for selection were found for; purely look-alike error when dose and formulation were constant, or for an aggregate metric of dose plus dose and formulation plus look-alike dose and/or formulation error. However the prevalence of observed error in the aggregate metric was over five times that of purely look-alike error.

Given the results of these experiments the authors would advocate a pragmatic approach with the implementation of a specific rule-based Tall Man variant for a limited and specified set of look-alike, sound-alike medicines. The common finding of these experiments is that this is unlikely to result in any greater harm when compared with the current standard of lowercase or uppercase.

The finding that error in practice is more likely to occur with dose, formulation or a combination of these with look-alike medicine name highlights the need for broader research. Understanding the effect of perceptual and cognitive mechanisms on visual processing may underpin interface designs that minimise any deleterious effects on recognition and selection, and maximise the benefits associated with highlighting potentially confusable portions of medicine names and routes of administration in the context of dose and formulation.

Objectives

NHS Connecting for Health (NHS CFH) wished to investigate the potential use of Tall Man lettering in e-prescribing or medication-ordering-systems software. Following the successful award of this contract, meetings were held with NHS CFH and representatives of the National Patient Safety Agency (NPSA) to formulate in detail the required research programme. The main research aim was to determine whether, in principle, the use of Tall Man lettering in drop-down selection menus of medicines in e-prescribing software reduced medicine-selection errors.

In order to do this, investigations would be conducted that would identify the impact on the selection of medicines in Tall Man lettering for both computerised prescribing and dispensing Information Technology (IT) systems. The work would investigate the key principle of using Tall Man lettering and not all instances of medicine names would be used. If a beneficial effect were to be found, then a simple method of measuring the effectiveness of Tall Man lettering in preventing error in selection from drop-down menus as presented by IT systems both for ordering and dispensing prescribed items could subsequently be devised. This research was viewed as the immediate priority and natural precursor for a sequence of investigations building towards a comprehensive understanding of the place of Tall Man lettering in minimising error and facilitating medicines management.

The target participants for experimental studies included individuals who prescribe medicines using relevant medication prescribing software systems, namely the following Health Care Practitioners (HCPs): General Medical Practitioners (GPs); hospital doctors; pharmacists in hospital and the community; and, pharmacy technicians in hospital and the community. Initial scoping studies were carried out which resulted in the proposal to perform three complementary experimental investigations.

Initial Scoping Studies

As participants were practitioners in the National Health Service (NHS), advice from the National Research Ethics Service was first obtained concerning whether the project required ethical approval or not. The documented decision was that the work should be viewed as service evaluation and consequently NHS research ethics approval was not required.

In order to scope the envisaged activity Table A (Appendix A, page 31) was derived which brings together the current recommendations for Tall Man nomenclature from; the Federal Drug Administration (FDA) Name Differentiation Project[1] and the Guidelines[2] and communications from the NPSA and NHS CFH. It is evident from this table that there is variation both in recommendation as to which medicines should be included; and, for individual medicines as to which letters should be differentiated. The table considers generic medicine names only. It was subsequently determined that the research must also address proprietary medicine names. Furthermore, while the original Tall Man concept was built on pairs of names, the FDA itself included a triad for Medroxyprogesterone, Methylprednisolone and Methyltestosterone. In order to make sense of those groupings most likely to cause confusion, this table presents an aggregate of similar ‘look-alike’ names and does not force pairing where there are potentially more than two names involved. Medicines are relevant to the UK if their names are recognised by the Prescription Pricing Division of the NHS Business Services Authority, Dictionary of Medicines and Devices and/or identifiable in the British National Formulary. Thus, for example, Medicines such as Dimenhydrinate and Diphenhydramine are not listed. The table identifies such groupings which are not initially considered relevant to this research, as UK participants will have no knowledge of the names.

Following the initial meeting with NHS CFH and the NPSA, one of the pharmacy dispensing systems (JAC[a]) currently in use was examined in detail. In this particular software the medicine names are presented on-screen in capitals with the route of administration in capitalised lowercase font. Subsequently other software systems used by GPs, pharmacists and pharmacy technicians were studied. An examination of software systems revealed that various approaches are in use and that a detailed survey of such available IT systems would therefore be required in order to contextualize and guide the research to ensure widespread real world applicability of the research findings.

Footnotes:
a: http://www.jac-pharmacy.co.uk/

The Research Programme

From the foregoing the following work was undertaken:

1. A literature review of visualisation in the context of drop-down menus or pick-lists as presented on computer displays. While broad background information on visualisation was available to inform subsequent experiments, specific literature relevant to the envisaged experiments could not be found.

2. A literature review of Tall Man lettering was undertaken to examine how others have used the approach and what success it has had. It was hoped this would elucidate the rationale for currently used formats of Tall Man and provide the basis for any rule-based variants.

3. A survey of NHS IT systems in use in England which are concerned with medicines management (including the NHS CFH supplier status of pharmacy systems[b] and GP Systems of Choice[a]) was carried out. This was performed to identify the mode-of-display presentation of drop-down menus, commonly termed 'pick lists', currently used for the selection of medicines. Choice, for example, of; font, font case, monitor resolution, and capacity to size the text box were determined. Research studies were then contextualized within these survey findings.

4. It was not possible, within the scope of this project, to examine all of the available proprietary and generic medicine names. Consequently, expert opinion was sought concerning which names are the most commonly confused and consequently a source of potential serious prescribing error. These were agreed with NPSA and NHS CFH prior to inclusion in experimental studies.

5. A series of experiments, using computer presentation of medicine names in lowercase, uppercase and three different Tall Man lettering formats were planned to be carried out using GPs and hospital doctors plus pharmacists and pharmacy technicians in hospital and community settings as participants. The studies included the refinements developed by Filik et al.,[3] Additionally, a modified version of the Reicher-Wheeler task[4,5] was planned which could quantify the level of perceptual confusability amongst visually similar letters and words, in this case medicine names. The adapted paradigm would involve the presentation of the medicine name, for example acetohexamide, in the context of its drop-down menu environment at a threshold of perception. Recognition would then be tested by asking participants to report the previously presented medicine name by virtue of a two-alternatives forced-choice between the presented medicine name and a matched, similar medicine name, in this case acetohexamide vs. acetazolamide, as presented in the drop-down format. The percentage of correct choices attained reflects the level of visual confusability between the two medicine names given in the forced choice. In this task performance can be compared across a number of stimulus text formats, including the Tall Man format, natural lowercase controls and uppercase test conditions. These two experimental paradigms would then provide key information about the effectiveness of Tall Man variants in reducing error in the selection of medicine names presented on-screen.

6. The first two experiments focused purely on visual perceptions of medicine names. In practice it was known that selection was in the context of multiple medicine names each with a discrete formulation and dose. Further, that complex manipulations of drop-down menus were required before a choice could be made.

Consequently, it was planned to either develop experimental software which, based on the information from the survey in 2 above, visually simulated the available medicine selection portion of Pharmacy and GP IT systems and which could be used to examine how individuals make appropriate selections, or modify existing medicine-selection software to allow examination of Tall Man lettering. It was decided to develop dedicated experimental software for this task, thus, enabling the greatest possible control over experimental conditions.

Footnotes:
b: http://www.connectingforhealth.nhs.uk/systemsandservices/eps/supplierstatus/pharmacy
c: http://www.connectingforhealth.nhs.uk/systemsandservices/gpsupport/gpsoc

A study was planned where participants were presented with medicine selection tasks and using search environments observed in practice would type in the letters of medicine names and progressively narrow the list then identify and select the target medicine, with its precise dose and formulation, amongst 'look-alike' confounders normally present in the system. Medicine lists would be taken from those in current use and participants would search for generic and branded medicine names just as they would in practice.

The medicine names would be presented either in capitals, Tall Man variants or in lowercase font. This would establish the principle of using Tall Man lettering in such software and whether its use decreases medicine selection errors. It was envisaged that all three experiments would triangulate to confirm a given direction of policy for the use of Tall Man format for medicine names as presented in drop-down menu prescribing and dispensing software.

Introduction

In the Department of Health (DH) publication 'Building a Safer NHS for Patients' it was recognised that confusion over the labelling and packaging of medicines may be a contributory factor to medication errors,[6,7] and that medicines should be labelled and packaged in such a way that confusion is removed.[6] The publication of the DH report prompted the Committee on the Safety of Medicines to establish a working group on the labelling and packaging of medicines. The working group reviewed the published evidence related to medication errors in which labelling and packaging were implicated as a causative factor. It made recommendations in respect of general labelling and packaging principles that should apply to all medicines. The observations and safe practice principles were published in a consultation document MLX 275.[8] Feedback from the consultation exercise was used as the basis of the Best Practice Guidance on the Labelling and Packaging of Medicines[9] published and implemented by the Medicines Control Agency from 1st March 2003. Substantive publications in 2003 added weight to the potential for look-alike or sound-alike medicine name confusion citing this as a factor in 8% and 25% of errors[10] with as much as a third being implicated in later work.[11] Included in the Best Practice Guide are the following recommendations:

- critical information should appear in as large a font size as possible to maximise legibility;
- the use of innovative pack design, that may incorporate the judicious use of colour, is to be encouraged to ensure accurate identification of the medicine; and,
- manufacturers are recommended to undertake user testing to ensure maximum clarity of user information.

Tall Man Lettering

One method which has been proposed to reduce medicine-name confusion errors is to print portions of the name in capital letters on packaging to emphasise differences between the names.[11, 12, 13] There is however, some evidence that Tall Man letters do impact on visual and tactile activity. In this context Tall Man lettering refers to the use of capitals within a word to accentuate differences; an example being 'carBAMAZepine' and 'carBIMazole' used for epilepsy and hyperthyroidism respectively. Clearly an error swapping such medicines would be likely to have detrimental patient consequences.

Key publications have been produced by the authors of this report which suggested that Tall Man lettering can: make similar names easier to distinguish in a same-different judgement task when participants were given the additional information that Tall Man letters were informative; improve recognition memory by increasing attention; and, improve selection from an array when lettering is simulated 'as' packaging. Also, that eye movement tracking corresponded with error data and refined that the use of Tall Man was recognised more accurately than names in lowercase when considered with the use of colour and other factors.[3,14,15,16] The acknowledged limitation of this research was the use of non-NHS participants as it could be argued that staff familiar with nomenclature in the non-Tall Man format might react differently when faced with change.

Thus, while preliminary research seems quite positive to support the use of Tall Man lettering, there are a number of questions still to be answered. In the context of electronic prescribing or medication ordering systems it is not fully known if the use of Tall Man lettering would be beneficial.

Background

The potential for look-alike, sound-alike medicine names to cause confusion has been highlighted for nearly 30 years. However, the option to reduce confusion errors by printing portions of the medicine name in capital letters to emphasise the differences between the names was, to the authors' knowledge, first discussed by Cohen in 1999.[17,18] For instance, he suggested that it was easier to differentiate 'DOBUTamine' and 'DOPamine' than 'dobutamine' and 'dopamine'.

The US FDA Name Differentiation Project implemented this idea in 2001. Following FDA recommendations, The Office of Generic Medicines requested that manufacturers of 16 look-alike name 'pairs' voluntarily revise the appearance of established names.[19.] Manufacturers were encouraged to produce labelling that visually differentiated names using "Tall Man" (capital) letters and perhaps also colour. By 2006, the United Kingdom National Pharmaceutical Association had published a list of 294 look-alike, sound-alike individual medicine names[20] and in the same year Gremillion and Hogan published a list of 166 discrete medicine names.[21] Further, the Institute for Safe Medication Practices (ISMP) updates a list which in April 2009 noted 357 individual medicines, which had the potential for confusion with one or more alternative look-alike, sound-alike medicines.

Interest was generated in differentiating medicine names through typography. In 2008 the ISMP conducted an on-line survey to garner opinion regarding the use of Tall Man letters. From the 451 survey responses received, 87% felt that the use of Tall Man lettering helps to reduce medicine selection errors, and 64% reported that Tall Man lettering has actually prevented them from dispensing or administering the wrong medication.[22]

It is reasonable that strategies for reducing name confusion errors must consider both dealing with existing confusable names, and preventing the approval of new names that may be confused with existing names.

A number of scientific studies have been carried out in an attempt to objectively assess the effectiveness of Tall Man lettering. Filik, Purdy, Gale & Gerrett (2004)[3] recorded university students' eye movements while they searched for a target product amongst an array of packs presented on a computer screen. The task was to indicate whether the target was present in the array. In fact, the target was never present, but was always replaced by a 'distractor' drug with a similar name (e.g. the target was chlorpromazine, but chlorpropamide was present in the array). The study design was balanced with 'filler' trials where the target *was* present. Names on the packs were either in lowercase or contained Tall Man lettering. Participants made fewer name confusion errors when the names included Tall Man letters. In addition, the eye movement data showed that participants spent less time looking at a distractor pack when the name contained Tall Man lettering, indicating less difficulty with the task in this case.

In 2006[14] three experiments were reported in which the effectiveness of Tall Man lettering on perceptual confusability was investigated using a "same-different" judgement task (Experiments 1 and 2) and on confusion in memory using a recognition memory task (Experiment 3). In Experiments 1 and 2, participants were timed as they decided whether similar name pairs which were presented side by side on a computer monitor were the same name or two different names. Names were either presented in lowercase, or with sections in Tall Man lettering. In Experiment 2, participants were aware of the purpose of Tall Man lettering, in Experiment 1 they were not. Results showed that highlighting sections of the names using Tall Man lettering made similar names easier to distinguish if participants were aware that this is the purpose of the intervention. Experiment 3 was a recognition memory task. Participants were presented with a list of five medicine names (one after the other), which they had to remember. They were then presented with a list of 10 names, five of which were in the original list, and five of which were similar distractors. Their task was to indicate whether or not they recognised the names as being one of the original five names, or a new name that they had not seen before. Names were either presented in lowercase, with sections in Tall Man, with sections in colour, or with sections that were both Tall Man and coloured. Results suggested that Tall Man lettering and/or colour did not make names less confusable in memory but that Tall Man letters may increase attention to the names.

More recently, Schell (2009)[12] reported findings from two computer-based sequential recognition experiments. Participants were shown a 'prime' drug name, followed by a target name, and the task was to indicate whether the target name was the same as the prime. In

Experiment 1, names were either presented in lowercase, with sections featuring “colour enhancement” (red lettering), or “case enhancement” (uppercase letters in place of lowercase letters). Participants in this experiment were college students. Results showed that neither colour nor case reduced confusion between similar names. That is they did not alter the likelihood of reporting that two names were the same when they were in fact different. In addition, presenting portions of the name in uppercase letters actually significantly increased the number of false alarms (i.e. indicating that the two names were different when they were in fact the same). However, Schell argued that this may be a positive outcome, as an increased tendency to report errors may lead to more actual errors being caught. Experiment 2 included six text enhancement types: no enhancement, colour enhancement, case-based enhancement, colour and case based enhancement, case based and size based enhancement (where the enhanced portion of the word was increased by 33% relative to the rest of the word) and all three enhancements combined (colour, case, and size). Participants were practising pharmacists and technicians from community and long-term care pharmacies. Results showed that none of these enhancements had a significant effect on accuracy. However, Schell noted that this may be due to a lack of statistical power in this case (N = 11), and that future research must increase the sample size.

In another study a small sample of 11 of acute care nurses were used.[13] The following text manipulations were examined:

HyrOXYzine HydrALAzine

Hydr**oxy**zine Hydr**ala**zine

Hydroxyzine Hydralazine

It was suggested that, from the results of a word recognition/memory task, the manipulation of reversing font and background colours seemed to be most effective, followed by Tall Man lettering, followed by bold type. Qualitative data suggested that the reversal and bold type, followed by Tall Man, made the names subjectively less confusable. However, no statistical analyses were presented, and the author stated that a larger scale study is required in order to be conclusive.

Thus, while preliminary research seems quite positive, there are a number of questions still to be answered. It is not known whether studies with university students reflect practice by HPCs. Studies with HPCs have used sample sizes that may be too small to lead to conclusive results. Assuming Tall Man lettering is shown to be effective, it is not known whether it should appear on, for example, secondary labelling, shelf labels, drop-down computer menus or blister packs. There appears to be no clear ‘rule’ for the implementation of Tall Man typography. Variation in Tall Man typography exists between FDA and ISMP lists. This highlights the issue that it is currently unknown which parts of the medicine name should be optimally highlighted in order to minimise selection error. Finally, despite extensive searches of the available literature, the authors could find no scientific studies that had examined the accuracy and response times of HCPs using drop-down menus or pick lists to select medicines.

In summary, there is a need to study HPCs as they select from pick lists of medicine names in varying formats of Tall Man to determine if there is an optimum design for reducing error and selection time.

As an adjunct to this background information, research has been conducted to suggest medicine naming conventions. A combination of conventions to avoid confusing combinations and Tall Man lettering where confusion currently exists would seem sensible.

A number of metrics which assess the similarity of both look-alike and sound-alike names have been evaluated in relation to medicine name confusion. Such metrics could be used to screen proposed new names to assess whether or not they are likely to be confused with existing names[23].

An evaluation[24] of 22 different computerised measures of orthographic similarity, orthographic distance, and phonetic distance, in respect to their sensitivity, specificity, and overall accuracy. Eleven of the 22 measures investigated were N-gram measures, which compute orthographic similarity by breaking words down into n-letter sub-sequences and then counting the sub-sequences that occurred in both words. Bigram methods use two-letter sub-sequences, whereas trigram methods use three-letter sub-sequences. For example, the bigrams for

“dobutamine” would be {_d, do, ob, bu, ut, ta, am, mi, in, ne, e_} and those for “dopamine” would be {_d, do, op, pa, am, mi, in, ne, e_}. A similarity score between 0 and 1 would then be computed using the Dice coefficient, orthographic similarity = $2C/(B + A)$, in which A is the number of bigrams in the first word, B is the number of bigrams in the second word, and C is the number of bigrams that occur in both words. “Dobutamine” and “dopamine” share seven bigrams {_d, do, am, mi, in, ne, e_}, giving a bigram similarity score of $(2 \times 7)/(11 + 9) = 0.7$. Another measure of orthographic similarity was called “longest common sequence”. This metric assesses the longest sub-sequence of letters that is common to both names. It is not necessary for the letters in the common subsequence to be adjacent in the original sequences.

Measures of orthographic distance that were assessed were edit distance measures. Edit distance refers to the number of changes (insertions, deletions, or substitutions) required to transform one name of the pair into the other name. Measures of phonetic distance combined edit distance with various phonetic transcription methods, which transform the orthographic representation of a word into a phonetic representation. The phonetic transformation methods included soundex, phonix, editex, tapered edit distance, omission key, and skeleton key. It was found that Trigram-2b was the most accurate orthographic similarity measure. Normalised edit distance was the most accurate orthographic distance measure, and editex was the most accurate phonetic distance measure. It was concluded[24] that the methods demonstrated in their study may not be accurate enough to serve as the sole basis for judgments about the likelihood of confusion, with the opinion of experts still being required.

More recently, the effectiveness of two new measures was compared[25]. One was based on orthographic similarity (“look-alike”), and the other based on phonetic similarity (“sound-alike”). They found that the new orthographic measure (called BI-SIM, which combines the advantages of several known measures) outperformed other commonly used measures of similarity. They also found that the new phonetic approach (ALINE, which estimates the similarity between two phonetically-transcribed words) outperformed orthographic approaches, on a test-set containing sound-alike confusion pairs. However, an approach that combines several different measures achieved the best results. It was stated that their system is currently being used as the basis of a system developed for the FDA for detection of confusable medicine names.

Survey of Current Electronic Prescribing /Dispensing Software

Some 19 companies were identified that supplied software for prescribing and/or dispensing purposes. All versions of these software presented lists of medicine names, on screen, from which NHS staff selected the appropriate therapy.

A 25 item questionnaire was devised and piloted that sought to determine the impact of recommendations that might be made by the Tall Man research. Questions investigated the: current screen resolution used by the software; use of colour; source of medicine names used; whether this medicine list could be modified by the software supplier or the end user. In particular it investigated key aspects of the pick list which was used to select a particular medicine name. Thus the: font used; font case; use of bold or italics, and current use of Tall Man lettering were investigated. The background to the companies’ decisions to display material as it did was also detailed and screen shots of the software in operation were examined. The process of the actual use of the software was investigated, for instance: the maximum or minimum number of letters required by the medicine name search field to identify the medicine name, the specific search terms used and the error correction processes.

A condition of completion was that no individual company would be subsequently identified by the results. Between September 2008 and January 2009 December companies were contacted by mail, email and telephoned individually to complete the data collection exercise. By the end date, data from 13 companies had been collected which represented systems currently implemented in 122 Trusts, 321 NHS hospitals, 8,000 community pharmacies and 3,620 GP surgeries.

The responses describe a complicated set of circumstances where companies populate the medicine selection lists by medicine names derived: ‘in-house’; from the DM&D; from the First databank list; or from combinations of in-house and DM&D; or in-house and First Databank. The majority indicated that they were able to alter the representation of medicine names in their software in a way that would allow for Tall Man implementation. Additionally, they all indicated that they had not implemented Tall Man within their systems.

With one exception, the situation is further complicated as lists of medicines are then altered to reflect local formularies and idiosyncrasies. It has been estimated that 80% of organisations do not use a standard database of medicines. Thus, each hospital pharmacy system has a different list of medicines, described in different ways that do not map to any other information systems.[26]

The authors believe that an important requirement for the full benefits of Tall Man lettering would be the use of a standard medicine database, such as the NHS Dictionary of Medicines and Devices.

There was considerable variation in the size of the medicine lists that were represented, most opting for a scroll bar system. Nine companies allowed the user to alter the size and shape of the drop-down pick list window. Most had fixed the manner in which the user interacted with the system.

While it would be possible for the implementation of Tall Man through capitalisation of specific medicine names, all companies responded that italic or bold font was not currently an option. From the responses it would appear that out of all the possible manipulations of medicine name characterisations, Tall Man would be the most easily to be implemented. Most companies demonstrated an understanding of what was required if Tall Man lettering were to be recommended and stated that they were waiting on relevant research and guidance before implementing any changes.

Tall Man Lettering Variants

From the preceding literature review of Tall Man research and an examination of current use of Tall Man lettering two approaches to deriving Tall Man lettering rigorously, termed 'Mid' and 'CD3', in a medicine's name were arrived at. Appendix B (page 33) gives the methodology for both of these.

The following textual formats were investigated in the experiments:

- 'Natural' (type 1)– the medicine name is presented entirely in lowercase, except where it is a proprietary name in which case the first letter is capitalised;
- 'Uppercase' (type 2)– all letters of the medicine name are presented in capitals;
- Tall Man (type3) 'Mid – where differentiating characters in the middle of a name are capitalised;
- Tall Man (type4) CD3 – where no more than three letters differentiating characters in the middle of a name are capitalised and the letter 'i' is exempt from change; and,
- Tall Man (type5) Wild – this is the term used here to refer to the currently available Tall Man variants. This was taken from the literature based on the FDA and ISMP examples.

Experimental Studies

In the following description of the experimental studies enough detail has been given to follow what was done and the analyses undertaken. To aid understanding, some of the detailed statistical analyses and associated data are not presented here but will be published subsequently. The three studies use different statistical designs for different purposes and consequently different Tall Man variants were used along with differing medicine name pairs. These are all detailed in the appropriate Appendices for clarity. Software was developed for each study and loaded onto each of five identical laptop computers. These laptops were then used by the participants.

Participants

Of the 144 participants that undertook the experiments 14 were excluded as they were involved in the piloting (1) or failed to complete all experiments (13). The following table summarises epidemiological aspects of the population of participants. There was no significant difference between males and females in age or years of practice. Excluding the one Hospital Doctor from the analysis, there was no difference in age or years of practice for males or females when broken down by sector of practice. Therefore, gender is not a significant influence on the analysis. While there was no significant difference in years of practice between the sectors of practice, there was a significant difference in age ($F= 6.487$, $p= 0.000$) with over 10 years difference between General Medical Practitioners and Hospital Pharmacy Technicians (table 1). The authors are aware that this reflects the known environment of practice. The sample for analysis varied with each experiment due to the elimination of outliers and variations within individual datasets. Additionally one medical student completed some tasks.

	Male	Female	General Medical Practitioner	Hospital Pharmacy Technician	Hospital Pharmacist	Community Pharmacist	Community Pharmacy Technician	Hospital Doctor
N	47	83	50	25	18	18	18	1
Mean Age (years)	36.30	35.95	40.42	29.64	34.39	35.06	35.89	32.00
SE	1.38	1.06	1.20	2.16	1.91	1.80	2.10	.
Mean Practice (years)	10.17	10.23	9.60	10.96	9.19	12.78	9.33	10.00
SE	1.22	.88	1.24	1.99	1.57	1.74	1.29	.

Table 1: epidemiological characteristics

Experiment one: Confusable Medicine Names

Introduction

The potential confusability of medicine names was examined by assessing the error rates and response times of participants when they were presented with a list of names and had to decide if a previously presented name was present in the list or not. In this study a single Tall Man variant was examined against natural lettering for medicine names.

Method

Participants
127 HCPs comprising 48 general practitioners, 16 community pharmacists, 18 community pharmacy technicians, 1 hospital doctor, 18 hospital pharmacists (1 pre-reg.), 25 hospital pharmacy technicians, and 1 medical student.

Materials and Design
Opinion from experts at the National Patient Safety Agency and NHS Connecting for Health was sought concerning which drug names are most commonly confused, of which 40 names (20 pairs) were selected as experimental materials (see Appendix C). In the task, one name from each confusable pair was presented as a target to search for. This resulted in 40 possible target names, as either the first name or the second name from each pair could appear as the target. The target was then present in or absent from a subsequently presented list of five drug names. When the target was absent from the list, it was replaced with the other half of its confusable pair, which was a 'distractor'. The other four items in the list all shared the same first letter as the target name, but had a different second letter wherever possible, so that only the distractor item was truly confusable with the target drug name. The target/distractor appeared an equal number of times in each position on the list (e.g., first, second, and so on) and other items were positioned randomly. Names were either presented in natural case (for generic names the entire name appeared in lowercase, for brand names, the initial letter was capitalised), or had sections in Tall Man letters. In the natural case condition, the other items in the list also appeared in natural case. In the Tall Man condition, the other items also contained Tall Man lettering.

The letters which should be converted to uppercase in the Tall Man condition were determined according to the 'CD3' rule. Names were presented in Arial 12 point font, and items in the list were left justified. The independent variables were whether or not the names contained Tall Man letters, and whether the target was present in or absent from the list. Each participant saw each item in each of the four conditions, resulting in 160 experimental trials in total. Dependent variables were error rates and response times.

Procedure
Participants were given on-screen instructions describing the task. There were 16 practice items, which consisted of the target words amiloride, amlodipine, hydralazine, and hydroxyzine, shown in all four experimental conditions (lowercase, Tall Man text formats with target present and target absent). An overview of each trial is provided in Figure 1 which shows screen shots taken from the computer display. During each trial, participants were first presented with a fixation cross in the centre of the screen (fig. 1a). They were instructed to look at the cross, and then to press the space bar when they were ready for the target medicine name to appear. The target medicine name was then shown for a period of 200ms (fig. 1b). The target was replaced by a pattern mask (consisting of a row of Xs), which remained on the screen for 500 ms (fig. 1c) before being replaced by a list of five medicine names (fig. 1d). Participants had to indicate whether the target was present in or absent from the list by pressing the "O" key on the keyboard for absent and the "P" key for present. Participants were instructed to respond as quickly and as accurately as possible.

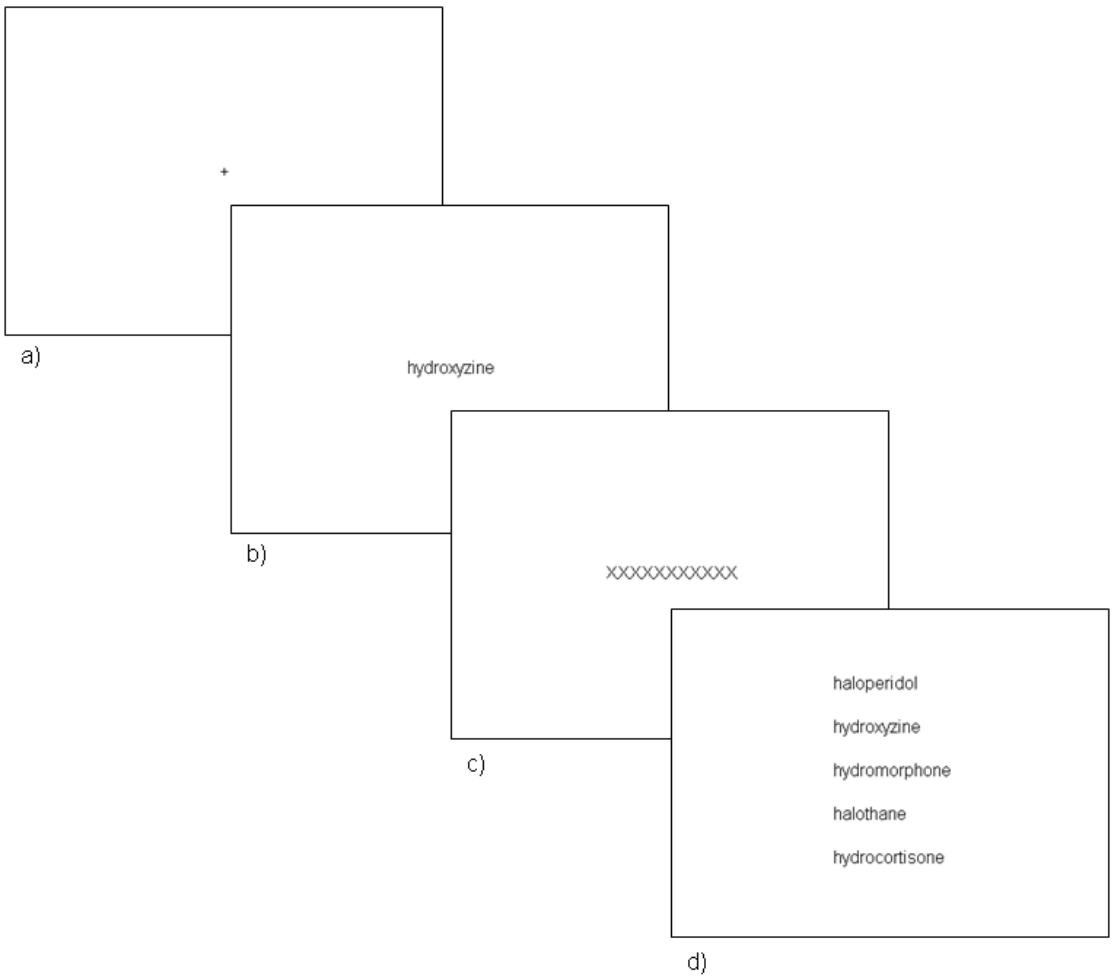

Figure 1. Screen shots providing an overview of each trial.

Results

Analysis
Two case (natural case vs. Tall Man) by two list (target absent vs. target present) ANOVAs were conducted on error rates and response time data.

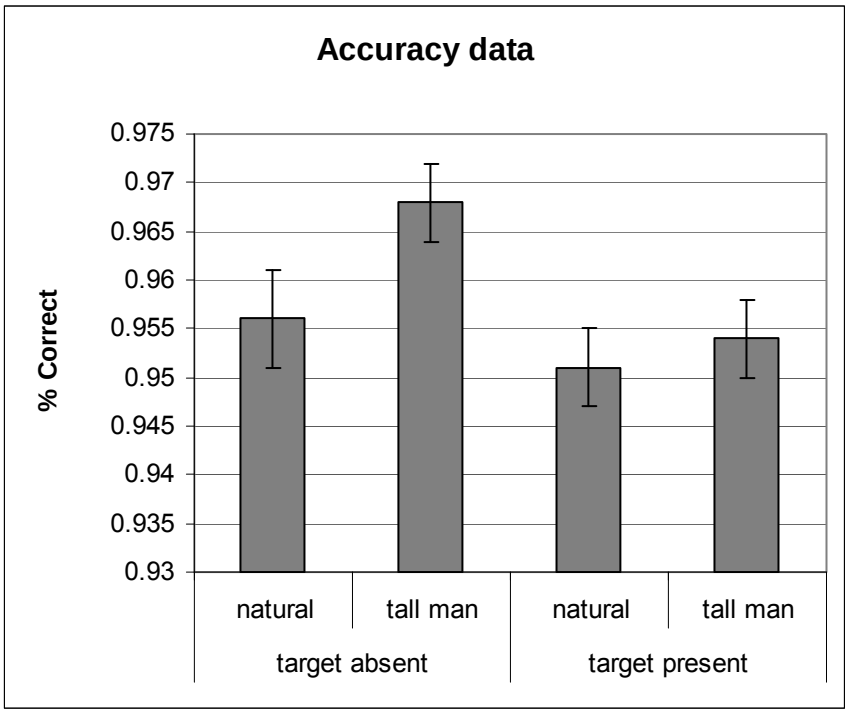

Figure 2. Error rates for the different conditions

Error rates, key finding: There was a significant case x list interaction F(1,126) = 4.29, p <.05. Planned comparisons revealed that when the target was absent from the list, participants were less likely to indicate that the target was present (i.e. to confuse a similar distractor for the target) when the name was in Tall Man than when it was in natural case, F(1,126) = 11.33, p<.005. In contrast, when the target was present, there was no difference between the two conditions (F<1). This pattern of results was confirmed when data were arcsine transformed (since the data are proportional), and when data from participants who had scored over 95% correct across all conditions were removed from the analysis.

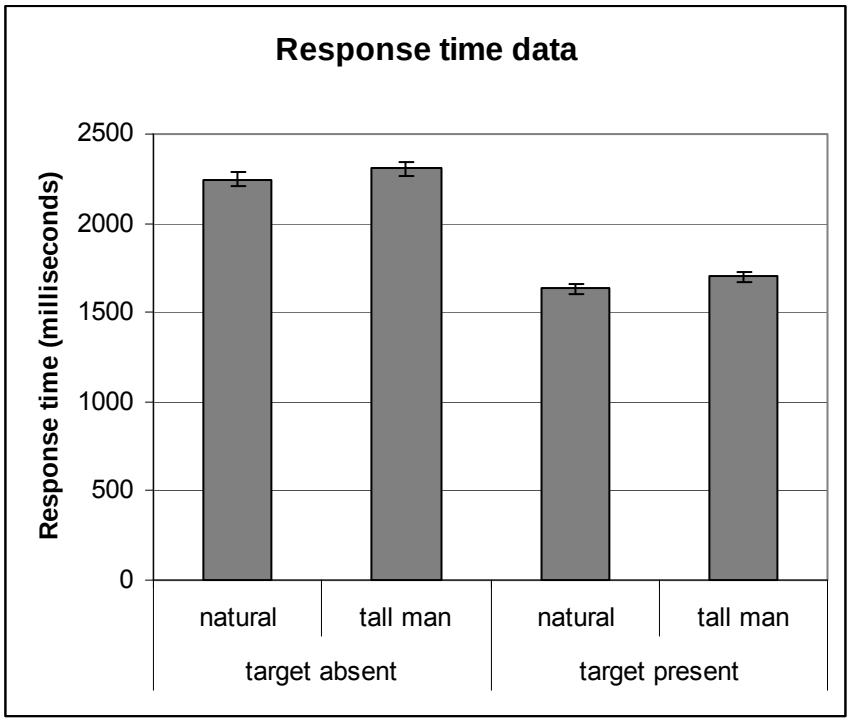

Figure 3. Response times in each condition

Response times, key findings: Prior to analysis, response times below 150ms and above 5000ms were removed, which accounted for 1.6% of the data. There were significantly longer response times for Tall Man than natural case, F(1,126) = 29.54, p<.001. There were also longer response times when the target was absent than when it was present, F(1,126) = 883.68, p<.001. There was no interaction, F<1.

Discussion

The accuracy data would suggest that Tall Man lettering led to a small, but significant, increase in accuracy. Specifically, participants were less likely to confuse a target name with a similar name when the names contained Tall Man lettering than when they were in natural case. The response time data would suggest that Tall Man lettering also led to a small increase (in the region of 60 milliseconds) in response times.

Conclusion

Tall Man lettering led to a small increase in accuracy, so in this task at least, would not appear to be detrimental to performance in name selection from a list.

Experiment two: The influence of Tall Man lettering on the simple, perceptual confusability of drug names

The Reicher-Wheeler task[4,5] is a means of examining perceptual processes in visual word recognition while controlling for the effects of cognitive strategies. These perceptual processes relate to largely preconscious neural functions involved in deciphering sensory information from the retina. They include the extraction of lines and contours, the synthesis of these basic features into letters, and then the combination of these letters into words, in conjunction with feedback from representations of these words stored in memory.[27,28] These perceptual activities proceed automatically and without conscious intervention in proficient readers.

In contrast to the perceptual processes described above, cognitive strategies in word recognition often occur at a conscious level. They include the use of guesswork to fill in unseen letters on the basis of known letters (a process akin to crossword completion) and the use of context to help identify a word. Cognitive strategies can distort the view of perceptual processes that is provided by a word recognition test. Thus, if perceptual processes are of interest, it is important to employ a test that controls, mitigates, or prevents the effects of cognitive strategies.

Here, the Reicher-Wheeler task has been adapted to test the confusability of medicine names when they are presented in one of five different textual formats. The intention of this experiment is to test whether the confusability of a medicine name varies when presented in natural case text (lowercase except for brand names where the initial letter is capitalised), uppercase text, or one of three Tall Man formats. Tall Man formats seek to highlight the critical portion of a medicine name that might cause one medicine name to be confused with another[14]. Highlighting is achieved by capitalising the critical portion of the medicine name. For instance, if “cefuroxime” is potentially confused for “ceftazidime” then it might be advantageous to highlight the portions that differ between the two medicine names: cefUROXime, cefTAZIDime. Three different rules for deciding which letters should be capitalised were tested here. These rules produce three different Tall Man formats: Wild, Mid, and CD3, each generated as described earlier (see Appendix B, page 33).

Of particular interest to this experiment is the assessment of the simple, perceptual confusability of medicine names in each of these textual formats. That is, the estimation of the influence of textual format on the probability of looking at a written medicine name and immediately misperceiving it as another, probably similar, medicine name. In real-life situations there is then the potential to correct any such error using cognitive processes. For instance, the context in which the medicine is prescribed might be incongruent, or letters that are not consistent with the now consciously available medicine name might be spotted. However, the Reicher-Wheeler task concentrates on processes up to the point of initial recognition when a medicine name first becomes consciously appreciated.

The Reicher-Wheeler task proceeds as follows. A participant is shown a medicine name in a given letter case condition. For example, “vincristine” might be presented in lowercase text. The participant is then asked to indicate which medicine name they have just seen by virtue of a two-alternatives forced choice. For example, “vincristine” and “vinblastine” might be offered as the alternatives. The two alternatives are matched as closely as possible. Consequently, the participant must have seen at least a portion of the elements that differ between the two choices (the “cri” of “vincristine”) in order to make the choice without resorting to guesswork. Where guesswork is employed, context and reconstruction from other letters that were seen are of no use. Thus, the effectiveness of complex cognitive strategies is minimised and only simple guesswork can be employed. The chance of success using simple guesswork alone is 50% when given two-alternatives.

Over the course of the experiment, the same medicine name is tested in all the different textual formats of interest. For example, the medicine name is also presented in uppercase text (e.g., “VINCRISTINE”) and in the Tall Man formats (e.g., “vinCRIstine”). Additionally, many other medicine names are tested too in order that the results of the experiment should be generalisable to a wide range of medicine names. The confusability of each medicine name is assessed by comparing the mean level of accuracy in selecting the correct alternative from the forced choice, for all the medicine names under scrutiny, across each of the textual formats.

Importantly, the level of difficulty of the task is tuned to the individual experimental participant’s sensory and perceptual abilities so that overall, they get approximately 75% of choices correct.

This is done with a training phase at the start of the experiment in which the contrast at which the medicine name is shown is adjusted gradually to work out that participant's "threshold of perception". If this is done successfully then, overall, mean accuracy across every medicine name in every textual format will be approximately 75%. Thus, for each individual textual format, accuracy has the scope to vary above this mid-level to a ceiling of 100% correct or below it to a floor of approximately 50% correct when the participant is forced to rely on simple guesswork.

In summary, the experiment tested accuracy of medicine name recognition across five different textual formats: natural case; uppercase; Wild Tall Man; Mid Tall Man; and CD3 Tall Man. The experiment adopted a repeated-measures design.

Method

Participants
A total of 133 HCPs took part in the experiment and contributed to the data set: 50 general practitioners, 17 community pharmacists, 20 community pharmacy technicians, 1 hospital doctor, 19 hospital pharmacists (1 pre-registration), 25 hospital pharmacy technicians, and 1 medical student (86 women; age, years: *M* = 36, range = 18 – 62).

Materials
Twenty confusable medicine name pairs (e.g. vincristine, vinblastine) were selected for experimental stimuli. These pairs were matched as closely as possible. (A preliminary analysis found that the pattern of results by textual format was not influenced by whether or not the two items of a pair were matched in terms of length in letters). A further 18, different, confusable medicine name pairs were selected for the training phase of the experiment. Each medicine name was presented in five different textual formats over the course of the experiment: natural case; uppercase; Wild Tall Man; Mid Tall Man; and CD3 Tall Man. All medicine names were rendered in Arial 12 point font. See Appendix C, page 38 for the experimental stimulus set used in the Reicher-Wheeler experiment.

Procedure
Participants were given on-screen instructions describing the task. The experiment then proceeded in two phases. First, a training phase enabled the estimation of the level of stimulus contrast required in order that the stimuli be presented at a threshold of perception. Then, an experimental phase collected the study data. The training phase led directly into the experimental phase and it was not obvious at which point the changeover occurred. Thus, participants were informed to try their hardest throughout the experiment.

The experiment consisted of 180 training phase trials followed by 200 experimental phase trials. Each trial proceeded as follows (please refer to figure 4 for an overview of each trial). The participant was presented with a cross-hair in the centre of the screen (fig. 4a). On pressing the space bar the cross-hair was replaced with the stimulus medicine name which was presented for 50 milliseconds (fig. 4b). After 50 milliseconds the stimulus was replaced with the two-alternatives forced choice which comprised the stimulus medicine name and the matched, confusable medicine name to which the stimulus had been paired in the stimulus set (fig. 4c). The alternatives were positioned one above the other with the position of the correct alternative randomised from one trial to the next. The participant was required to select which alternative matched the stimulus that was presented just previously by pressing the up or down arrow key for the upper or lower choice, respectively. On making a selection, the two alternatives were replaced with the cross-hair and the participant was able to initiate the next stimulus presentation by pressing the space bar.

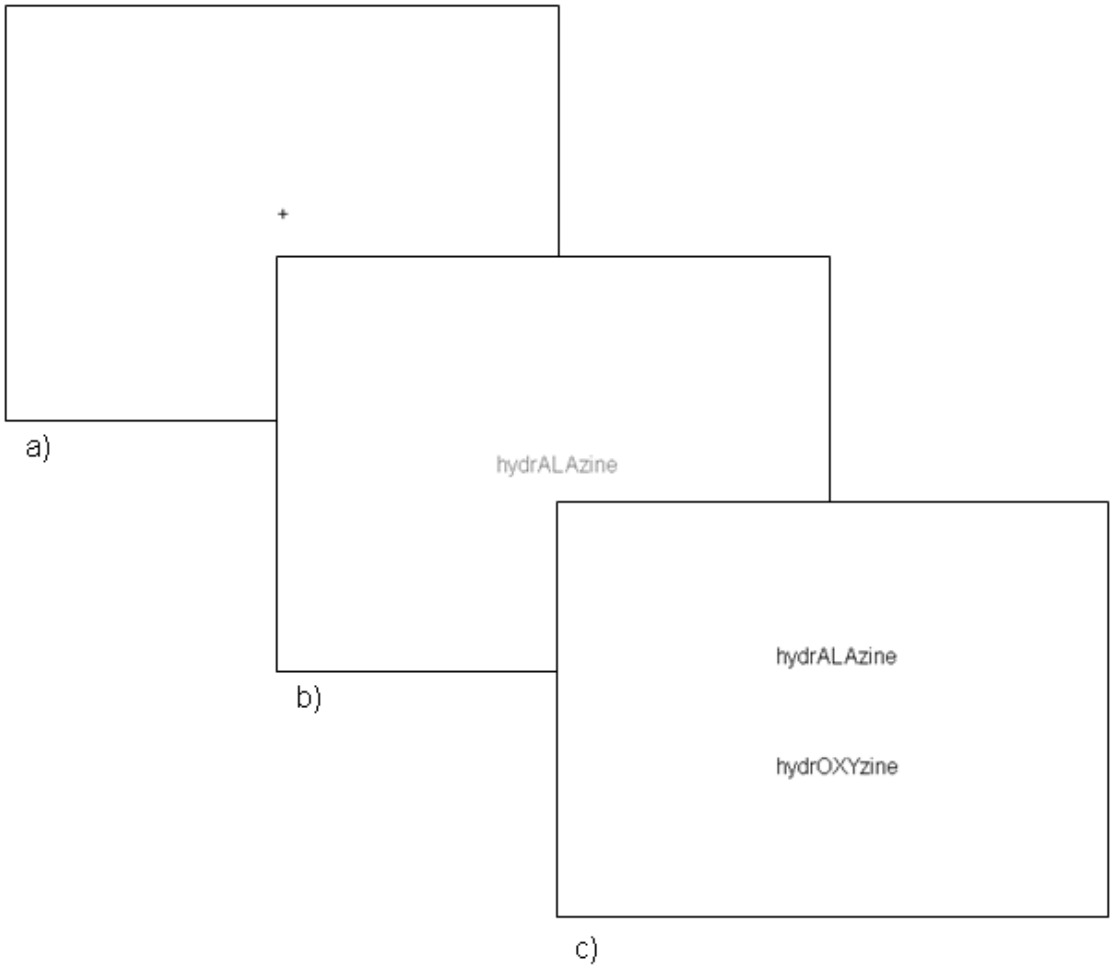

Figure 4. Screen shots providing an overview of each trial.

During the training phase each participant saw each of the 36 medicine names of the training set, once in each of the five textual formats. The medicine names were presented in a pseudo-randomised order such that every 10 trials each participant saw each of the five textual formats twice. Initially, stimuli were shown at the maximum possible contrast as black text upon a white background. Every cycle of 10 trials, average response accuracy across those 10 trials was calculated and contrast was adjusted up or down with a staircase procedure in an attempt to bring average performance over the next 10 trials to approximately 75% correct. The luminance of the stimulus was adjusted in greyscale while the background remained white. At the end of the training phase, the level of contrast that had supported an accuracy level closest to 75% was derived. This contrast level was used throughout the subsequent experimental phase of the experiment and was not adjusted further. Performance during the training phase did not contribute to the experimental data set.

During the experimental phase each participant saw each of the 40 medicine names of the experimental set, once in each of the five textual formats. Again, the medicine names were presented in a pseudo-randomised order such that every 10 trials each participant saw each of the five textual formats twice. Within the bounds of this criterion, stimuli were selected at random with the further proviso that the participant had not been tested on that medicine name in that textual format, previously. Following these rules, a different pseudo-randomised order was generated for each participant. This feature was designed to distribute any influence of fatigue and varying attention evenly across the experimental conditions.

Results

The data were subjected to a one way, repeated-measures ANOVA with 5 levels: textual format (natural, Wild Tall Man, Mid Tall Man, CD3 Tall Man, uppercase). Proportion correct was the dependent variable. Each data point, in each textual format, for each participant represented the mean of proportion correct across 40 medicine names. The threshold for statistical significance (the α-level) was set at $p = .05$.

There was a main effect of textual format $F(3.68, 485.89) = 34.21$, $p = .000$ (the data failed Mauchly's Test of Sphericity, therefore, the degrees of freedom were corrected using the Greenhouse-Geisser estimates of sphericity). Pair-wise post-hoc tests were used to resolve the main effect of textual format and the Bonferroni correction was applied. Accuracy on natural case medicine names ($M = 0.78$, $SD = 0.12$, $p = .000$) was lower than on Wild Tall Man ($M = 0.84$, $SD = 0.11$, $p = .000$), Mid Tall Man ($M = 0.84$, $SD = 0.11$, $p = .000$), CD3 Tall Man ($M = 0.82$, $SD = 0.12$, $p = .000$), and uppercase ($M = 0.84$, $SD = 0.11$, $p = .000$) medicine names. Additionally, accuracy on CD3 Tall Man medicine names was lower than on Mid Tall Man ($p = .032$) and uppercase medicine names ($p = .002$). See table 2 and figure 5 for a summary of these results.

Textual format	***M***	***SD***
Natural	0.78	0.12
Wild Tall Man	0.84	0.11
Mid Tall Man	0.84	0.11
CD3 Tall Man	0.82	0.12
Uppercase	0.84	0.11

Table 2. Proportion correct analysed by textual format

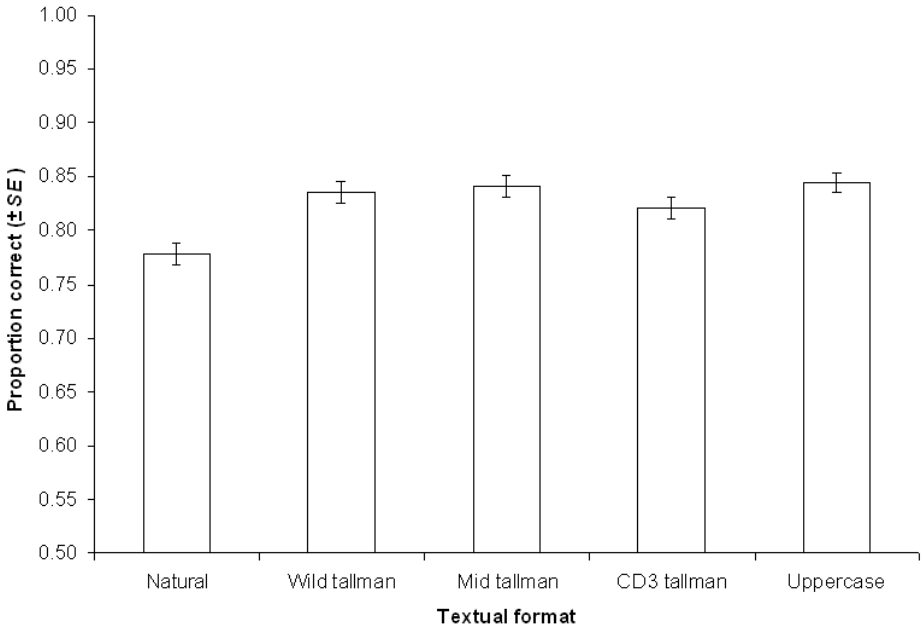

Figure 5. Proportion correct analysed by textual format

Discussion

The influence of textual format on the simple, perceptual confusability of medicine names was tested. Textual format was found to influence accuracy in medicine name recognition. The nature of this influence has two main components: a disadvantage associated with the natural textual format which uses entirely lowercase letters except where the initial letter is capitalised for a brand name; and the influence of capitalising either the entire medicine name or just a critical portion of the medicine name.

The disadvantage associated with the presentation of medicine names in a natural textual format

Accuracy was lower when the medicine name was presented in natural case text (principally lowercase, except when the initial letter was capitalised for a brand name), compared to when either a critical portion of the medicine name was presented in uppercase text (as in the Tall Man formats) or when all the medicine name was presented in uppercase text. This result is somewhat counterintuitive as it is known that lowercase letters are more physically distinctive than uppercase letters and that they are less often confused for one another.[29] However, the font under investigation was Arial 12 point (which is commonly used in e-prescribing software). In this font uppercase letters are predominantly larger than lowercase letters. Thus, uppercase letters may have been easier to see on account of a size advantage. This might explain why the CD3 Tall Man format supported lower accuracy than the Mid Tall Man format: The Mid Tall Man format entailed the capitalisation of all the letters in the critical portion of a medicine name whilst the CD3 Tall Man format involved the capitalisation of a maximum of three such letters. Thus, in the Mid Tall Man format the posited size advantage would be conferred upon a greater number of letters. Further studies would be required in order to determine if the size advantage is an issue, perhaps involving a customised font in which the sizes of uppercase and lowercase letters were matched.

The influence of capitalising either the entire medicine name or just a critical portion of the medicine name

It was thought that a Tall Man textual format might confer an advantage in medicine name recognition, possibly by drawing attention to a critical portion of the medicine name. Comparison amongst accuracies on the Wild Tall Man, Mid Tall Man, CD3 Tall Man, and uppercase textual formats offers no evidence to suggest that capitalising a critical portion of the medicine name confers an advantage over and above that obtained by capitalising the whole medicine name. It is possible that the utility of the Tall Man approach is hampered as it necessarily involves the mixing of uppercase and lowercase letters within a medicine name. A considerable body of research indicates that case mixing disrupts word recognition, although the origins of this effect are uncertain.[30] However, it is noted that the Wild and Mid Tall Man formats support levels of accuracy that are equivalent to those observed with the uppercase format. If case mixing were the only factor that determined performance on Tall Man formatted medicine names then it might be expected that the uppercase format would support the highest level of accuracy. One possibility is that highlighting the critical portion of the medicine name does confer an advantage in recognition accuracy, but that this advantage is then dampened by the effects of case mixing that are a necessary part of the current Tall Man formats. This issue requires further investigation. Perhaps the Tall Man format can be adapted, or an alternative developed, to avoid or minimise case mixing whilst still highlighting the critical portion of a medicine name.

Conclusion

The present experiment investigated the influence of Tall Man textual formats on the simple, perceptual confusability of medicine names presented in the 12 point Arial font. Adopting performance on lowercase text as a baseline, it was found that either capitalising a critical portion of the medicine name using a Tall Man format, or capitalising the entire medicine name, will improve recognition accuracy. However, highlighting a portion of the name in Tall Man lettering has the additional function of signalling that this name is at risk of being confused with another name. Presenting the entire name in uppercase might not have the same ‘alerting’ effect, as people are used to seeing words in uppercase. Thus, the size advantage conferred by uppercase letters may be the main factor in determining performance at the perceptual level. Further work is required to determine if lowercase text will improve accuracy over and above that conferred by uppercase text, if their letter sizes are matched.

Thus, the use of either Tall Man or entirely uppercase text formatting will enhance medicine name perception over the level achievable with natural text formatting. Of the options investigated here, formatting medicine names in either entirely uppercase text or according to the “Mid” Tall Man rule would offer the greatest boon to perception.

The experimental Tall Man format necessarily involved case mixing within a medicine name. It is possible that the act of highlighting the critical portion of a medicine name is beneficial to recognition accuracy, but in the Tall Man formats this benefit is reduced by case mixing. Case mixing is known to hamper word recognition; however, most studies reported in the literature have employed alternating case, for example, a representation such as ‘aLtErNaTiNg’. In the Tall Man experiments blocks of characters were capitalised, and only with the Tall Man (type 4) CD3 rule was there a comparable mixture of upper and lower case due to the rule of not capitalising ‘i’ and confusing it with ‘l’. It is hypothesised that the use of blocks of capitals in contrast to alternating case may have been less disruptive to reading. Future work should attempt to find a means of highlighting the critical portion of a medicine name while ensuring that any manipulation does not disrupt word recognition.

Experiment three: The Pick List

Introduction

The third experiment was designed to mimic the actions that HCPs undertake in the selection of medicines from menu-driven pick lists. Progressive narrowing of alphabetical lists of medicine names, with their respective dose and formulations, was the method identified in the survey of prescribing and dispensing IT software solutions.

Method

Materials

Forty two medicine names were selected for experimental stimuli. These medicine names were selected so as to be confusable with certain other names that would appear in the pick list and were presented in each of five textual formats or case conditions: natural case text (lowercase except for brand names where the initial letter is capitalised); uppercase text; and three Tall Man formats - Wild, Mid, and CD3. The Wild format was taken from the literature as advised by the FDA and the ISMP. The Mid and CD3 types were produced according to set procedures (Appendix B). The experimental stimuli (appendix C, page 43) were presented in the pick list, intermingled amongst a series of distractor medicine names (see appendix C, page 47).

The experimental and distractor medicine names were paired to appropriate dosages and formulations. In the pick list, individual medicine names were repeated for as many dosages and formulations as were deemed necessary to mimic real-world e-prescribing software. When viewed in the context of the experiment the participant would see a list of medicine names coupled with variations in dosage and formulation, as might be seen in e-prescribing software (see figure 6).

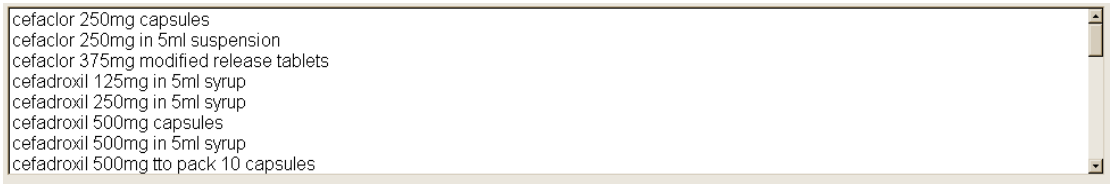

Figure 6. An example of medicine names, dosages, and formulations displayed in the pick list of the mock e-prescribing software.

Procedure

Participants were given on-screen instructions describing the task. The experiment then proceeded in two phases. First, a practice phase, which comprised four trials, allowed participants to get used to the experimental procedure. The practice phase was followed by 210 experimental trials, without a break and without notification that the practice phase had ended and that the experiment proper had begun. The practice audio prompts did not feature any experimental medicine names.

The experiment was automated on computer using an e-prescribing software simulation developed in-house. Each trial proceeded in the following manner. The participant mouse-clicked an on-screen button to indicate that they were ready for the trial to begin. On clicking the button, an audio prompt was played over headphones. The audio prompt detailed the medicine name to be searched for and selected, followed by the specific dose and formulation. Experimental audio prompts varied between 1 and 6 seconds in length (M = 3.33, SD = 0.85). When the audio prompt had finished playing, the participant was presented with a text search entry box which was positioned above a “pick list” box. The pick list box would show the results of the text search that was based on the input from the text search entry box. Both the text search entry and pick list boxes were initially blank (see figure 7).

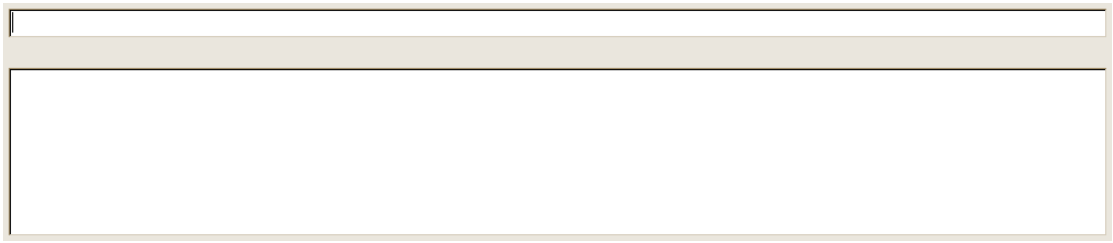

Figure 7. The blank text search box above the blank pick list.

Participants were required to type letters into the text search entry box in order to identify the medicine name that they had heard in the immediately prior audio prompt. The letters had to be typed in the order that they would appear in the written medicine name. For instance, having heard “vincristine”, participants might type “v”. Then the pick list box would be populated with all the experimental and distractor items that matched this letter-string (i.e. all medicine names that start with the letter “v”, see fig. 8).

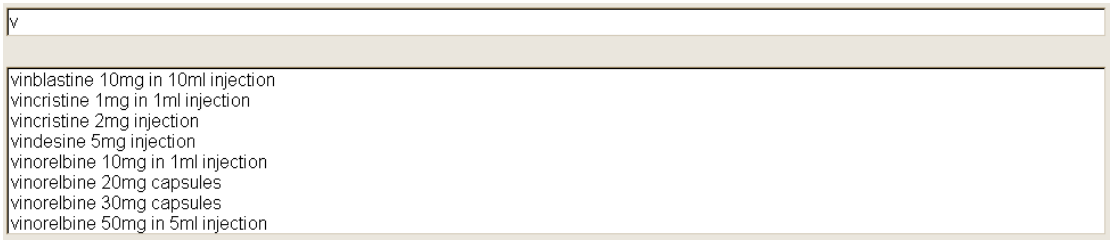

Figure 8. The appearance of the text search entry box and pick list following input of the letter “v”.

It was then possible to refine the search by adding additional letters. For example, “vinc” would identify only vincristine and each dosage and formulation of vincristine would appear in the pick list (see figure 9). The text search operated on the basis of medicine name, dosage and formulation, but it operated from left to right and was anchored to the first letter of the medicine name.

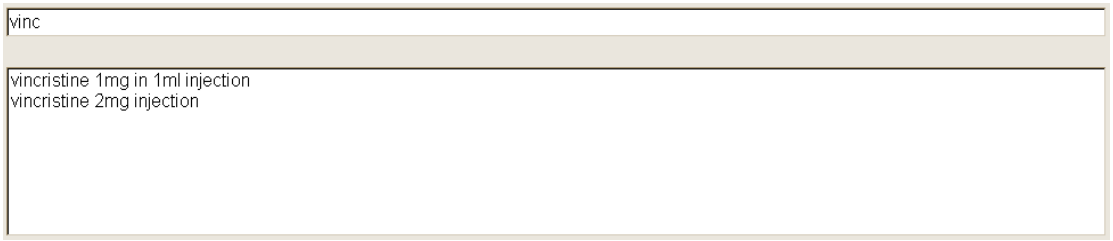

Figure 9. The appearance of the text search entry box and pick list following input of the letter-string “vinc”.

A maximum of eight items were displayed in the pick list at any one time, in alphabetical order. Where more than eight items matched the text search, the pick list offered a scroll bar to allow participants to examine the entire list of matched items (see fig. 1). Participants were free to add letters to or delete letters from their search strings. Each iteration of the text search for each experimental trial was recorded. The medicine names of any experimental items (but not distractor items) found by the text search were displayed in the textual format to be tested on that trial. Text searches were not case sensitive. (See figure 10 for an example of the appearance of the text search entry box and pick list following the input of letter “v” on a trial testing the uppercase textual format.)

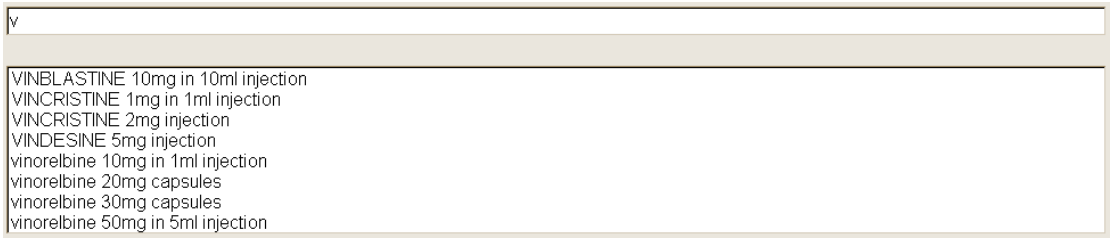

Figure 10. An example of the appearance of the text search entry box and pick list following the input of letter “v” on a trial testing the uppercase textual format.

Participants were required to select the item from the pick list, that they thought matched the immediately prior audio prompt in terms of both medicine name and combination of dosage and formulation. Selection from the pick list was made by double-clicking the item to be selected using the mouse. Participants were free to take as long as they wished over their text searches and selections. When the participant had made their selection, the selected item was recorded automatically alongside the audio prompt that had been given and the response time. Then the participant was presented with a button with which to initiate the audio prompt for the next trial.

During the experimental phase each participant received 210 trials: each of the 42 medicine names of the experimental set were tested 5 times, once for each of the 5 textual formats. The medicine names were tested in a pseudo-randomised order such that every 10 trials each participant was tested twice on each of the five textual formats. This feature was designed to distribute any influence of fatigue and varying attention evenly across the experimental conditions. Within the bounds of this criterion, stimuli were selected at random with the further proviso that that the participant had not been tested on that medicine name in that textual format previously. Following these rules, each computer generated a different pseudo-randomised order for each participant. The reaction time counter started when the input text boxes were made visible and stopped when the selection was made by double-clicking.

Analysis

Data were coded independently by two of the authors and the coding compared. The former coded by assessing each instance of an error individually and in the context of the supporting data, the latter coded according to electronic manipulation of the input and selected medicine. Initial coding was to the following eight categories:

1. wrong strength;
2. wrong formulation;
3. wrong medicine name;
4. incorrect entry;
5. incorrect hearing;
6. (wrong strength or formulation) and wrong medicine name;
7. no response; and,
8. wrong strength and formulation.

Of 28,770 cases (137 participants x 210 trials) the following exclusions were made:

- 58 where no selection was made. There was no pattern in failure to select by participant, case condition or medicine name;
- 111 where on inspection it was deduced that the participant had not heard the vocal instruction clearly and had chosen from a dropdown menu starting with an incorrect first character; and,
- 8 cases for one participant as these comprised the total before exiting the programme.

Data were exported from each of the five computers, compiled and a program written to aggregate the data to Excel spreadsheets. Data were then arranged by pivot tables and pasted as raw data into SPSS version 15.

Significance was defined as $p<0.05$ and error bars displayed the 95% confidence interval. For Repeated Measures Analysis of Variance (ANOVA) where sphericity was contravened, the Greenhouse-Geisser measure was used for within-subject effects.

Limitations

A limitation of this experiment was the ability of participants to engage in selection without distraction. In ‘normal’ practice distraction is common and has been shown to impact adversely on error.[31] Participants were not allowed to use medicine-name-specific numerical codes or other short-cuts that were observed in some software.
In order to avoid prior visual stimulus, medicine names were conveyed in audio instructions. The clarity and recognition of medicine name pronunciation, participant’s listening abilities, and the ability to remember instruction were confounders in this experiment.

Results

The data were analysed by participant and the act of selecting from the pick list as a case. The time in milliseconds (msec) was noted for pick list activity with; no observed error (no error), and error in name only and aggregation of list items 1, 2, 6 and 8 activity where an error was noted in medicine dose, formulation, dose and formulation, dose and medicine name, formulation and medicine name or dose plus formulation and medicine name ('aggregate of error'). The three resultant variables were assessed independently and as a group. Inspection of Figures 11, 12 and 13 visually confirms the relationships that were determined for 'case'.

Of the 28,602 cases, 81 were observed for error in name only. These were distributed between the five case conditions as follows: Natural 19; Uppercase 16; Mid Tall Man 17; CD3 Tall Man 13, and Wild Tall Man 16. Similarly for the aggregate of error, 441 observations were distributed as follows: Natural 86; Uppercase 91; Mid Tall Man 95; CD3 Tall Man 92 and Wild Tall Man 79. Inspection of standardised, adjusted residuals for the resulting contingency table revealed no significant cell and no significant association between case condition and error type for error in name only or aggregate of error.

This was consistent with a Repeated Measures ANOVA of the proportion of error in name only observed for each participant (within subject effects, Greenhouse-Geisser F 0.319, p 0.846). Where error in name only is concerned the case condition where the time for pick list selection is most likely to be the same as that were no error is observed is with case condition 4 (Tall Man type 4 CD3).

Repeated measures ANOVA revealed no significant differences in error rate between case conditions for the aggregate of error metric where dose, formulation and medicine name were varyingly involved (within subject effects, Greenhouse-Geisser F 0.579, p 0.673). This is consistent with visual inspection of the overlapping error bars of response time in figures 12 and 13. The lowest error rate for the aggregate of error metric was with Wild Tall Man (n 137, mean 0.01372 errors) and this was linked to the longest case response time.

Repeated measures ANOVA for the average response time in the 137 sample of participants where no error was made in selection showed a significant relationship between the five case conditions (within subject effects, Greenhouse-Geisser F 2.727 p 0.041). Mean response times in msec for the case conditions were as follows: Natural, 5763; Uppercase, 5639; Mid Tall Man 5,625; CD3 Tall Man 5,880 and Wild Tall Man 5,597. This result is consistent with the distribution of individual case responses (figure 11, n= 28,070) and visual inspection of the 95% confidence interval error bars (Figures 12 and 13)

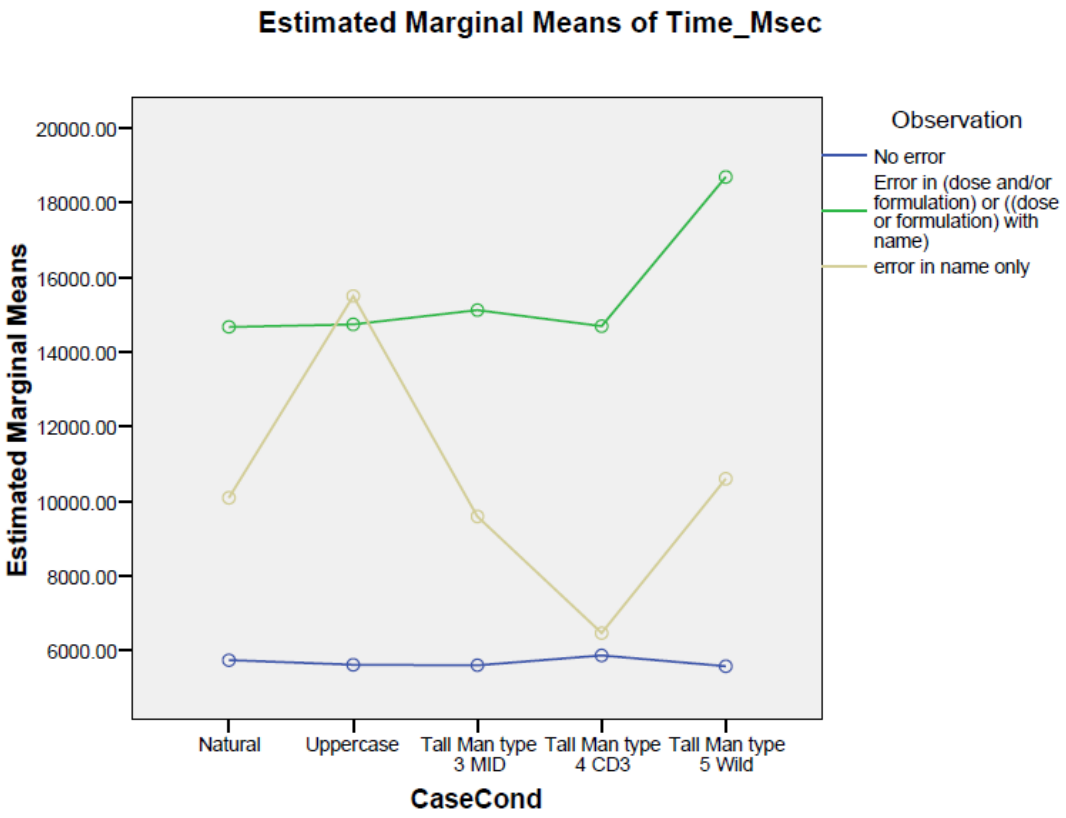

Figure 11: Means of time by case condition by observation

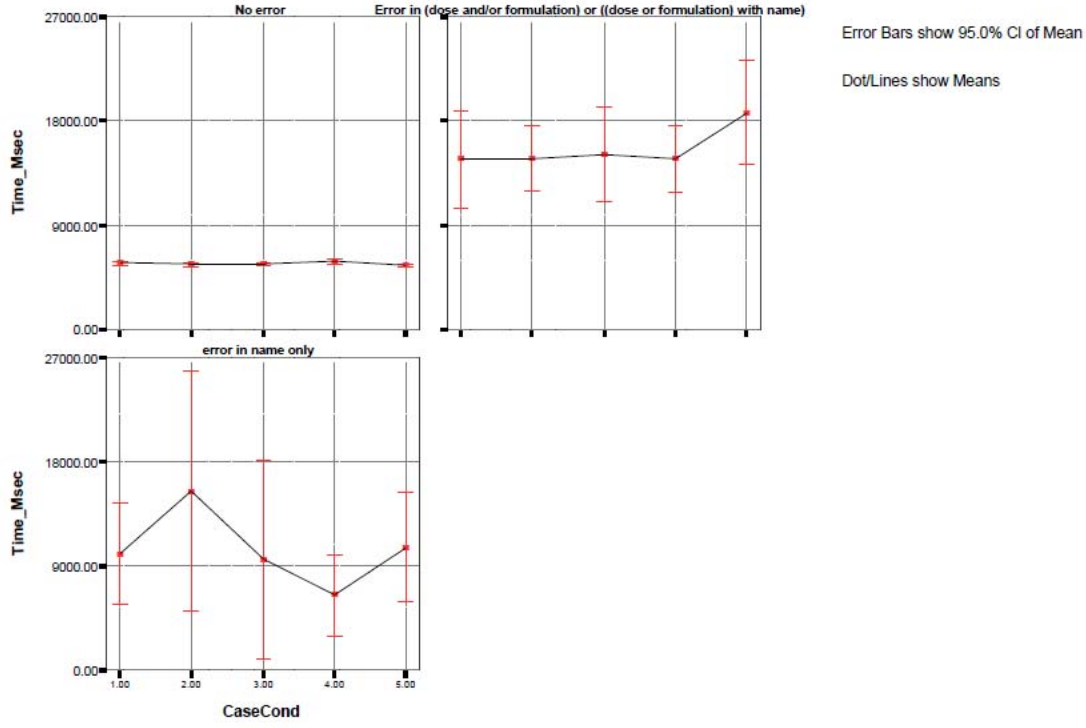

Figure 12: Error for observed categories. In the figure legend CaseCond 1 through 5 represents respectively: Natural; Uppercase; Tall Man type3 Mid; Tall Man type4 CD3; and Tall Man type5, Wild.

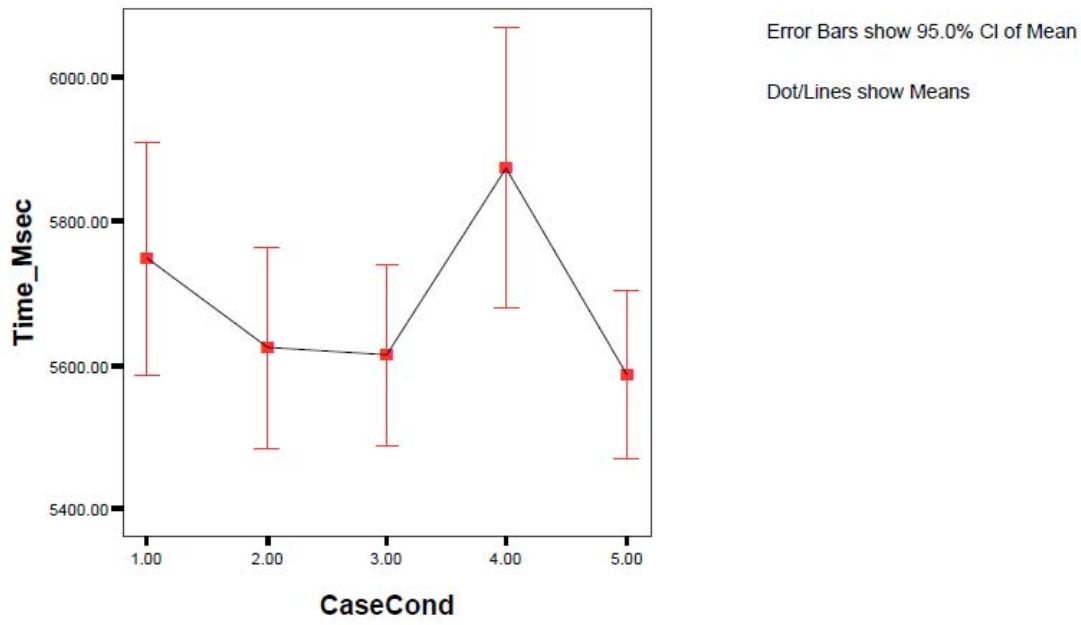

Figure 13: 'No error' confidence intervals. In the figure legend CaseCond 1 through 5 represents respectively: Natural; Uppercase; Tall Man type3 Mid; Tall Man type4 CD3; and Tall Man type5, Wild.

Discussion

The finding that there was no significant association between participant error rate and case condition implies that selection of a variant of Tall Man will not lead to more error than currently demonstrated. While the hoped for significant improvement in error rate for look-alike medicines using Tall Man variants was not observed statistically, nevertheless there were indicators of an effect. All variants of Tall Man capitalisation had lower rates for 'error in name only' than the pure uppercase or natural case conditions. On this basis the Tall Man (type3) CD3 would be the logical choice. However it was noted that this variant had the longest response time when no error was made. Placing this in perspective the range was 283 msec representing only a 5% change.

From the larger more complex and dominant aggregate of error rate, it is clear that error is more related to dose and formulation or a combination of these than with look-alike medicine name. Research to investigate these dependencies will be needed before a definitive practice-based appreciation of Tall Man can be made.

The use of Tall Man type did significantly affect the time for the action of selecting a medicine. The selection of Wild Tall Man showed the greatest reduction in time when no error was detected. This observed reduction goes against the bulk of literature concerned with reading research where any alteration in the natural expected form of a word results in an increase in time for the assimilation of meaning. This variant of case condition was also linked to an increased time in 'error in name only' and even more obviously the 'aggregate' variable of error.

If time to select is considered a surrogate indicator for drawing attention to the detail of a medicine name plus its formulation and dose, then paradoxically this would suggest that Wild Tall Man would be the choice as it minimises error at the expense of time yet where no error is detected has the fastest response time. This variant might be conceived as the common sense approach to naming and was a composite of FDA and ISMP, published and advised types. Unfortunately there are inconsistencies between these two organisations in the advice as to exactly how individual medicines should appear. Further the authors could discern no clear 'rule' associated with this common sense approach.

The Tall Man (type4) Mid and Tall Man (Type3) CD3 were conceived to take advantage of known reading strategies where visualisation of the first and last characters of a medicine name is followed by inspection of the central portion. Many of the Wild Tall Man variants are, by default, created by application of these rules.

From Appendix C the application of the Tall Man (type 3) Mid rule is easy to appreciate whereas the Tall Man (Type3) CD3 method still requires some interpretation. Even though the Wild Tall Man variant showed some improvement over the other types in ‘no error’ pick list response time, no other significant results were found.

Conclusion

The authors believe that the easily implemented structured approach of Tall Man (type 3) Mid should be recommended for application across the NHS where HCPs are faced with medicine names and look-alike, sound-alike confusion has been identified. The authors also believe that the use of this typography should be restricted to those look-alike combinations known or highly suspected to produce confusion. A formal mechanism for approving the adoption of Tall Man will need to be created and the responsibility identified between NHS CFH and involved organisations such as the NPSA, Medicines and Healthcare products Regulatory Agency and European Medicines Agency (EMEA).

References

1. Federal Drug Administration (FDA) Name Differentiation Project, 2001 http://www.fda.gov/CDER/Drug/MedErrors/nameDiff.htm), accessed 14th March 2008.

2. Best Practice Guidance on the Labelling and Packaging of Medicines. http://www.mhra.gov.uk/home/groups/comms-ic/documents/publication/con007554.pdf first publised December 2002, originally published December 2002, this format June 2003 (accessed 14th March 2008)

3. Filik R, Purdy KJ, Gale AG, Gerrett D. Drug name confusion: Evaluating the effectiveness of capital ("Tall Man") letters using eye movement data. Social Science and Medicine 2004;59:2597-601.

4. Reicher, G. M. (1969). Perceptual recognition as a function of meaningfulness of stimulus material. Journal of Experimental Psychology, 81, 275-80.

5. Wheeler, D. D. (1970). Processes in word recognition. Cognitive Psychology, 1, 59-85.

6. Smith J. Building a Safer NHS for Patients: Improving Medication Safety. NHS Health Development Agency, 2004

7. Starr C. When Drug Names Spell Trouble. Drug Topics. 2000:May15;49-58

8. MLX275: Report to the Committee on the Safety of Medicines, from the Working Group on the Labelling and Packaging of Medicines, London, CSM, 2001.

9. Slee A, Cousins D. Guidelines for the design and presentation of medication elements required in electronic prescribing or medication ordering systems. http://www.dmd.nhs.uk/documentation/item_8_guidelines_for_the_design_and_presentation_of_medication_elements_in_ep_0.1__2.pdf (accessed 14th March 2008)

10. Hoffman JM, Proulx SM. Medication errors caused by confusable drug names. Drug Safety 2003;26 (7):445-52.

11. Berman A. Reducing medication errors through naming, labeling and packaging. *Journal of Medical Systems*, 2004; 28(1): 9-27.

12. Schell K.L. Using enhanced text to facilitate recognition of drug names: evidence from two experimental studies. Applied Ergonomics, 2009, 40:1, 82-90

13. Gabriele S. The role of typography in differentiating look-alike / sound alike drug names. Healthcare Quarterly 2006; 9 (special issue):88-95.

14. Filik R, Purdy KJ, Gale AG, Gerrett D. Labelling of medicines and patient safety: Evaluating methods of reducing drug name confusion. Human Factors. 2006;48(1):39-47.

15. Filik R, Gale AG, Purdy KJ, Gerrett D. Medication errors and human factors. In McCabe P (Ed.), Contemporary Ergonomics. London:Taylor & Francis, 2003:471-6.

16. Filik R, Purdy KJ, Gale AG, Gerrett D (2003). Investigating medication errors caused by confusable drug names. In Schmalhofer F, Young RM, Katz G (Eds.), Proceedings of EuroCogSci 03, London: Lawrence Erlbaum Associates. 2003:383.

17. Cohen MR. (Ed.). Medication errors. Washington, DC: American Pharmaceutical Association. 1999

18. Cohen MR. (Ed.). Medication errors (2nd Revised Edition). Washington, DC: American Pharmaceutical Association 2006.

19. Federal Drug Administration. Name differentiation project. http://www.fda.gov/CDER/Drug/MedErrors/nameDiff.htm (accessed April 2009)

20. National Pharmacy Association. Similar names 2006:(June). http://www.npa.co.uk/ (accessed April 2009)

21. Gremillion L, Hogan DJ. Dermatologic look- or sound-alike medications. J Drugs Dermatol 2004:3(1):61-4

22. Institute for Safe Medication Practices. Use of tall man letters is gaining wide acceptance. http://www.ismp.org/Newsletters/acutecare/articles/20080731.asp (accessed April 2009)

23. Lambert BL, Lin S-J, Tan KH. Designing safe drug names. Drug Safety 2005;28, 495-512.

24. Lambert BL, Lin S-J, Chang K-Y, Ghandi SK. Similarity as a risk factor in drug-name confusion errors: The look-alike (orthographic) and sound-alike (phonetic) model. Medical care, 1999;37:1214-25.

25. Kondrak G, Dorr B. Automatic identification of confusable drug names. Artificial Intelligence in Medicine, 2006;36:29-42.

26. Davies A, Finesilver J, Stokoe H. Addressing pharmacy computer system issues within NHS hospitals. Pharmaceut J 2009;282:280

27. McClelland JL., Rumelhart DE. An interactive activation model of context effects in letter perception: I. An account of basic findings. Psychological Review, 1981:88(5):375-407.

28. Rumelhart DE, McClelland JL. An interactive activation model of context effects in letter perception: II. The contextual enhancement effect and some tests and extensions of the model. Psychological Review, 1982;89(1):60-94.

29. Geyer LH. Recognition and confusion of the lowercase alphabet. Perception and Psychophysics, 1977;22(5):487-90.

30. Mayall K, Humphreys GW, Olson A. Disruption to word or letter processing? The origins of case-mixing effects. Journal of Experimental Psychology: Learning, Memory and Cognition, 1997;23(5):1275-86.

31. Biron AD, Loiselle CG, Levoie-Tremblay M. Work interruptions and their contribution to medication administration errors: An evidence review. Worldviews Evidence-Based Nursing 2009;10(10):1-17

Appendix A: Tall Man lettering

Table A: Tall Man Lettering

Names	Tall Man typography	UK availability	
		PPA	BNF
Acetohexamide* Acetazolamide*	acetoHEXAMIDE or acetoHEXamide acetaZOLAMIDE or acetaZOLamide	No Yes	Yes Yes
Amiloride†‡ Amilodpine†‡	aMILORide† or aMILOride‡ aMILODpine† or aMLOdipine‡	Yes Yes	Yes Yes
Bupropion*† Buspirone*†	buPROPion* or buPROPION† busPIRone* or busPIRIONE†	Yes Yes	Yes yes
Carbamazepine† Carbimazole†	carBAMAZepine carBIMazole	Yes Yes	Yes Yes
Cafalexin‡ Cefaclore‡ Cefadroxil‡	cefaLEXin cefaCLORE cefaDROXIL	No No Yes	Yes Yes Yes
Cefixime‡ Cefotaxime‡ Cefpodoxime‡ Ceftazidime‡ Cefuroxime‡	cefIXime cefOTAXime cefPODOXime cefTAZIDime cefUROXime	Yes Yes Yes No Yes	Yes Yes Yes Yes Yes
Cefradine‡ Ceftriazone‡	cefRADINE cefTRIAZONE	Yes No	Yes Yes
Chlorpromazine*† Chlorpropamide*†	chlorproMAZINE chlorproPAMIDE	Yes No	Yes Yes
Clomiphene*† Clomipramine*†	clomiPHENE or clomiFENE (UK) clomiPRAMINE	As Clomifene Yes Yes	Yes Yes
Cyclosporine* Cycloserine*	cycloSPORINE or ciclosporine (UK) cycloSERINE	As Ciclosporin Yes No	Yes Yes
Daunorubicin*† Doxorubicin*† Dobutamine† Dopamine†	DAUNOrubicin DOXOrubicin DOBUTamine DOPamine	No Yes No No	Yes Yes Yes Yes
Dimenhydrinate* Diphenhydramine*	dimenhyDRINATE diphenhydrAMINE	No No	No No
Glipizide*† Glyburide* Gibenclamide† Gliclazide†	glipiZIDE glyBURIDE giBENCLamide gliCLAzide	Yes No No Yes	Yes No Yes Yes
Hydralazine*† Hydroxyzine*†	hydrALAZINE hydrOXYzine or hydrOXYZINE†	Yes Yes	Yes Yes
Medroxyprogesterone*† Methylprednisolone*†	medroxyPROGESTERone* or medroxyPROGESTERONE† methylPREDNISolone* or	Yes No	Yes Yes

Methyltestosterone*	methylPREDNISOLONE† methylTESTOSTERone	No	No
Nicardipine*†‡ Nifedipine*†‡ Nimodipine‡ Nisoldipine‡	NICARdipine* or niCARdipine† NIFEdipine* or niFEDipine† niMOdipine niSOLdipine	Yes Yes No No	Yes Yes Yes Yes
Penicillamine† Penicillin†	peniciLLAMINE peniciLLIN	Yes Yes	Yes Yes
Prednisone* Prednisolone*	predniSONE prednisoLONE	No Yes	No Yes
Pregaday† Pregabalin†	PregADAY PregABALIN	No No	Yes Yes
Sulfadiazine* Sulfisoxazole*	sulfADIAZINE sulfiSOXAZOLE	Yes No	Yes No
Tolazamide* Tolbutamide*	TOLAZamide TOLBUTamide	No Yes	No Yes
Vinblastine*† Vincristine*† Vindesine	vinBLAStine vinCRIStine vinDEsine	Yes No No	Yes Yes Yes
Felodipine‡ Isradipine‡ Lacidipine‡ Lercanidipine‡	FELOdipine‡ ISRAdipine LACIdipine LERCANIdipine	Yes Yes No No	Yes Yes Yes Yes

Legend

* = As listed by the Federal Drug Administration (FDA)
† = As Listed in reference 2.
‡ = as suggested by email NPSA OCCO (Tall Man author's interpretations)
PPA = Prescription Pricing Authority
BNF = British National Formulary

Some items here are not listed in the PPA or the BNF and were excluded for study. Where they are in a paired grouping this similarly affects the other 'look-alike' name.

Appendix B: 'Tall Man' rules

The Development of Tall Man variants

The Methodology for Producing Mid-type Tall Man Medicine Names

The Mid 'rule' was created by taking two or more look-alike, sound-alike medicine names and;

Step one
Working from the first letter of the medicine name take each common character to the right until two or more characters are different, and from that point on capitalise the characters.

Thus:	**Become:**
cefuroxime	cefUROXIME
cefotaxime	cefOTAXIME
ceftazidime	cefTAZIDIME

Step two
Working from the last letter of the word take each capitalized common character to the left until two or more characters are different, and change the capital letters to that point back to lowercase.

Thus:	**Become:**
cefUROXIME	cefUROXime
cefOTAXIME	cefOTAXime
cefTAZIDIME	cefTAZIDime

This works for pairs of medicine names or groups.

Examples of final Mid-Tall Man Names

Standard medicine name display	**Midi-type Tall Man medicine name display**
cefuroxime	cefUROXime
cefotaxime	cefOTAXime
ceftazidime	cefTAZIDime

The Methodology for Producing CD3-type Tall Man Medicine Names

The CD3 'rule' was created by taking two or more look-alike, sound-alike medicine names and;

Step one
Working from the first letter of the medicine name take each common character to the right until two or more characters are different, and from that point on capitalise the characters. The letter 'i' is excluded and is always in lowercase.

Thus:	**Become:**
cefuroxime	cefUROXIME
cefotaxime	cefOTAXIME
ceftazidime	cefTAZIDIME

Step two
Working from the last letter of the word take each capitalized common character to the left until two or more characters are different, Continue until there are potentially three characters in uppercase and change the capital letters to that point back to lowercase. The letter 'i' is excluded and is always in lowercase.

Thus:	**Become:**
cefUROXIME	cefUROxime
cefOTAXIME	cefOTAxime
cefTAZIDIME	cefTAZidime

This works for pairs of medicine names or groups.

The absolute application of this method breaks down where there are no common characters in Step two (such as cefaCLor, cefaDROxil, cefaLEXin) where the approach to capitalise centrally over-rides Step two; where capitalisation would result in common characters in the same vertical space and the method directs the focus away from the centre, such as carbAmazepine and carbimazOle.

Examples of final CD3-Tall Man names

Standard medicine name display	**CD3-type Tall Man medicine name display**
cefuroxime	cefUROxime
cefotaxime	cefOTAxime
ceftazidime	cefTAZidime

Appendix C: Medicine names

The stimulus set used in the Confusable Medicine Names Experiment

Target	Matched foil	Foil 2	Foil3	Foil4	Foil5	Textual format
azathioprine	azithromycin	aciclovir	adrenaline	alfentanil	amphotericin	Natural
azithromycin	azathioprine	abciximab	albendazole	amantadine	anistreplase	Natural
carbamazepine	carbimazole	cefpodoxime	chlorambucil	cisplatin	clonidine	Natural
carbimazole	carbamazepine	cetirizine	chlorhexidine	ciprofloxacin	clopidogrel	Natural
cefaclor	cefadroxil	calcitriol	clonazepam	clozapine	cyclizine	Natural
cefadroxil	cefaclor	calamine	cilazapril	colestyramine	cycloserine	Natural
cefalexin	ceftriazone	carbidopa	chloroquine	cimetidine	clofazimine	Natural
ceftriazone	cefalexin	calciferol	chlorpropamide	clorazepate	ciclosporin	Natural
cefixime	cefotaxime	captopril	citalopram	colchicine	cytarabine	Natural
cefotaxime	cefixime	carbaryl	chlorocresol	colistin	cyclopentolate	Natural
ceftazidime	cefuroxime	calcitonin	cilostazol	clindamycin	colecalciferol	Natural
cefuroxime	ceftazidime	calcipotriol	chlortalidone	clotrimazole	cyclopentolate	Natural
clomifene	clomipramine	carbachol	celecoxib	cidofovir	collodion	Natural
clomipramine	clomifene	capreomycin	ceftriaxone	cilastatin	colestipol	Natural
Depo-Medrone	Depo-Provera	Dipentum	Dovonex cream	Dulco-lax	Dyspamet	Natural
Depo-Provera	Depo-Medrone	Diamox Sequels	Dobutrex	Durogesic	Dynastat	Natural
dopamine	dobutamine	daunorubicin	deferiprone	diazepam	dutasteride	Natural
dobutamine	dopamine	danaparoid	desogestrel	diclofenac	duloxetine	Natural
dipyridamole	disopyramide	dactinomycin	desmopressin	domperidone	dydrogesterone	Natural
disopyramide	dipyridamole	dalfopristin	debrisoquine	donepezil	dyphylline	Natural
folic acid	folinic acid	famotidine	felodipine	finasteride	flecainide	Natural
folinic acid	folic acid	famiclovir	fenbufen	filgrastim	flunisolide	Natural
gliclazide	glipizide	gabapentin	gentamicin	goserelin	guanethidine	Natural
glipizide	gliclazide	gallamine	gemfibrozil	gonadorelin	guanidine	Natural
mercaptamine	mercaptopurine	magaldrate	misoprostol	montelukast	mupirocin	Natural

Target	Matched foil	Foil 2	Foil3	Foil4	Foil5	Textual format
mercaptopurine	mercaptamine	mandanol	mivacurium	mometasone	mupirocin	Natural
nicardipine	nifedipine	nafarelin	netilmicin	norfloxacin	nystatin	Natural
nifedipine	nicardipine	nadolol	nebivolol	norgestrel	nystatin	Natural
penicillamine	penicillin	papaverine	phenindione	piperonal	propofol	Natural
penicillin	penicillamine	paclitaxel	phenytoin	piroxicam	pravastatin	Natural
pregabalin	Pregaday	Panadol	pergolide	phenylephrine	pyridoxine	Natural
Pregaday	pregabalin	parabens	Peroxyl	Phimetin	Pylorid	Natural
Rifadin	Rifinah	Ranzac	Rebetol	Rocaltrol	Rubex	Natural
Rifinah	Rifadin	Rapitil	Reductil	Rosex	Rusyde	Natural
vinblastine	vincristine	valproate	vancomycin	verapamil	vorinostat	Natural
vincristine	vinblastine	valrubicin	valsartan	verteporfin	voriconazole	Natural
Zofran	Zoton	Zanaflex	Zelapar	Zidoval	Zydol	Natural
Zoton	Zofran	Zantac	Zentel	Zileze	Zyloric	Natural
zolpidem	zopiclone	zalcitabine	ziconotide	zinc oxide	zuclopenthixol	Natural
zopiclone	zolpidem	zanamivir	zidovudine	zinc chloride	zuclopenthixol	Natural
azathioPrine	azithroMycin	aciCLOvir	adrenALine	alfENtanil	amPHOtericin	CD3 tallman
azithroMycin	azathioPrine	abCIXimab	albENDazole	amANTadine	anistrepLAse	CD3 tallman
carbAmazepine	carbimazOle	cefPODoxime	chloramBUCil	cisPLAtin	cloniDINe	CD3 tallman
carbimazOle	carbAmazepine	cetiriZINe	chlorHEXidine	ciprofLOXacin	clopiDOGrel	CD3 tallman
cefaCLor	cefaDROxil	calcitriOL	clonAZepam	cloZAPine	cycLIZine	CD3 tallman
cefaDROxil	cefaCLor	caLAMine	cilaZAPril	colesTYRamine	cycloSERine	CD3 tallman
cefaLEXin	cefTRiazone	carbiDOpa	chloroQuine	ciMEtidine	cloFAZimine	CD3 tallman
cefTRiazone	cefaLEXin	calciFERol	chlorproPAMide	cloRAZepate	ciCLOsporin	CD3 tallman
cefiXime	cefOTAxime	capTOpril	ciTALopram	colChicine	cyTArabine	CD3 tallman
cefOTAxime	cefiXime	carbARyl	chloroCREsol	coliSTin	cyclopentOLate	CD3 tallman
cefTAZidime	cefUROxime	calcitONin	ciloSTazol	cliNdamycin	coleCALciferol	CD3 tallman
cefUROxime	cefTAZidime	calciPOTriol	chlorTALidone	cloTRimazole	cyclopentOLate	CD3 tallman
clomiFEne	clomiPRAmine	carbAChol	celeCOxib	ciDOfovir	colloDion	CD3 tallman
clomiPRAmine	clomiFEne	capREOmycin	ceftRIAxone	cilaSTAtin	colestiPol	CD3 tallman
Depo-MEDrone	Depo-PROvera	DipeNtum	DovoNex cream	DuLco-lax	DyspAMet	CD3 tallman
Depo-PROvera	Depo-MEDrone	DiamOX	DobutREx	DurOGesic	DynaSTat	CD3 tallman

Target	Matched foil	Foil 2	Foil3	Foil4	Foil5	Textual format
		Sequels				
doPAMine	doBUTamine	daUNorubicin	deFEriprone	diazEPam	dutASteride	CD3 tallman
doBUTamine	doPAMine	danapARoid	desOGestrel	dicLOfenac	duLOXetine	CD3 tallman
dipyriDamole	disopyRAmide	dacTINomycin	desMopressin	domPERidone	dyDROgesterone	CD3 tallman
disopyRAmide	dipyriDamole	dalfopRIStin	deBrisoquine	doNepezil	dyPHylline	CD3 tallman
foLic acid	foliNic acid	famOTidine	feloDIPine	finAsteride	fleCAinide	CD3 tallman
foliNic acid	foLic acid	famiCLovir	fenBUfen	filGrastim	fluniSOLide	CD3 tallman
gliCLAzide	gliPizide	gaBapentin	genTAmicin	goSerelin	guanEThidine	CD3 tallman
gliPizide	gliCLAzide	gaLLamine	gemFIBrozil	goNadorelin	guaNIDine	CD3 tallman
mercaptAMine	mercaptoPURine	maGALdrate	miSoprostol	monTELukast	mUpirocin	CD3 tallman
mercaptoPURine	mercaptAMine	manDAnol	miVAcurium	moMetasone	mUpirocin	CD3 tallman
niCARdipine	niFEDipine	naFARelin	neTILmicin	norFLOxacin	nySTatin	CD3 tallman
niFEDipine	niCARdipine	naDOLol	neBIVolol	norgestRel	nySTatin	CD3 tallman
penicillAMine	peniciLLin	papaveRINe	pheninDione	piperONal	propOFol	CD3 tallman
peniciLLin	penicillAMine	paCLitaxel	phenyTOin	pirOXicam	praVastatin	CD3 tallman
pregaBalin	PregaDay	PanaDol	perGolide	phenylePHrine	pyridOXine	CD3 tallman
PregaDay	pregaBalin	paraBEns	PerOxyl	PhiMETin	PyloRid	CD3 tallman
RifaDin	RifiNah	RanZac	RebeTol	RocAltrol	RuBex	CD3 tallman
RifiNah	RifaDin	RapiTil	RedUctil	RoSex	RUsyde	CD3 tallman
vinBLAstine	vinCRistine	valproATe	vaNcomycin	verApamil	voriNOstat	CD3 tallman
vinCRistine	vinBLAstine	valrUBicin	valsARtan	verTEporfin	voriCONazole	CD3 tallman
ZoFRan	ZoTon	ZanafLex	ZeLApar	ZiDoval	ZyDol	CD3 tallman
ZoTon	ZoFRan	ZanTAc	ZenTel	ZiLeze	ZyLoric	CD3 tallman
zolpiDem	zopiCLone	zalCitabine	zicoNotide	zinc Oxide	zucLOpenthixol	CD3 tallman
zopiCLone	zolpiDem	zaNamivir	zidoVudine	zinc Chloride	zucLOpenthixol	CD3 tallman

The stimulus set used in the Reicher-Wheeler experiment

Stimulus	Matched alternative	Textual format
azathioprine	azithromycin	Natural
azithromycin	azathioprine	Natural
carbamazepine	carbimazole	Natural
carbimazole	carbamazepine	Natural
cefaclor	cefadroxil	Natural
cefadroxil	cefaclor	Natural
cefalexin	ceftriazone	Natural
ceftriazone	cefalexin	Natural
cefixime	cefotaxime	Natural
cefotaxime	cefixime	Natural
ceftazidime	cefuroxime	Natural
cefuroxime	ceftazidime	Natural
clomifene	clomipramine	Natural
clomipramine	clomifene	Natural
Depo-Medrone	Depo-Provera	Natural
Depo-Provera	Depo-Medrone	Natural
dopamine	dobutamine	Natural
dobutamine	dopamine	Natural
dipyridamole	disopyramide	Natural
disopyramide	dipyridamole	Natural
folic acid	folinic acid	Natural
folinic acid	folic acid	Natural
gliclazide	glipizide	Natural
glipizide	gliclazide	Natural
mercaptamine	mercaptopurine	Natural
mercaptopurine	mercaptamine	Natural
nicardipine	nifedipine	Natural
nifedipine	nicardipine	Natural
penicillamine	penicillin	Natural
penicillin	penicillamine	Natural
pregabalin	Pregaday	Natural
Pregaday	pregabalin	Natural
Rifadin	Rifinah	Natural
Rifinah	Rifadin	Natural
vinblastine	vincristine	Natural
vincristine	vinblastine	Natural
Zofran	Zoton	Natural
Zoton	Zofran	Natural
zolpidem	zopiclone	Natural
zopiclone	zolpidem	Natural
AZATHIOPRINE	AZITHROMYCIN	Uppercase
AZITHROMYCIN	AZATHIOPRINE	Uppercase
CARBAMAZEPINE	CARBIMAZOLE	Uppercase
CARBIMAZOLE	CARBAMAZEPINE	Uppercase
CEFACLOR	CEFADROXIL	Uppercase
CEFADROXIL	CEFACLOR	Uppercase
CEFALEXIN	CEFTRIAZONE	Uppercase
CEFTRIAZONE	CEFALEXIN	Uppercase
CEFIXIME	CEFOTAXIME	Uppercase
CEFOTAXIME	CEFIXIME	Uppercase

CEFTAZIDIME	CEFUROXIME	Uppercase
CEFUROXIME	CEFTAZIDIME	Uppercase
CLOMIFENE	CLOMIPRAMINE	Uppercase
CLOMIPRAMINE	CLOMIFENE	Uppercase
DEPO-MEDRONE	DEPO-PROVERA	Uppercase
DEPO-PROVERA	DEPO-MEDRONE	Uppercase
DOPAMINE	DOBUTAMINE	Uppercase
DOBUTAMINE	DOPAMINE	Uppercase
DIPYRIDAMOLE	DISOPYRAMIDE	Uppercase
DISOPYRAMIDE	DIPYRIDAMOLE	Uppercase
FOLIC ACID	FOLINIC ACID	Uppercase
FOLINIC ACID	FOLIC ACID	Uppercase
GLICLAZIDE	GLIPIZIDE	Uppercase
GLIPIZIDE	GLICLAZIDE	Uppercase
MERCAPTAMINE	MERCAPTOPURINE	Uppercase
MERCAPTOPURINE	MERCAPTAMINE	Uppercase
NICARDIPINE	NIFEDIPINE	Uppercase
NIFEDIPINE	NICARDIPINE	Uppercase
PENICILLAMINE	PENICILLIN	Uppercase
PENICILLIN	PENICILLAMINE	Uppercase
PREGABALIN	PREGADAY	Uppercase
PREGADAY	PREGABALIN	Uppercase
RIFADIN	RIFINAH	Uppercase
RIFINAH	RIFADIN	Uppercase
VINBLASTINE	VINCRISTINE	Uppercase
VINCRISTINE	VINBLASTINE	Uppercase
ZOFRAN	ZOTON	Uppercase
ZOTON	ZOFRAN	Uppercase
ZOLPIDEM	ZOPICLONE	Uppercase
ZOPICLONE	ZOLPIDEM	Uppercase
azATHIOPRINE	azITHROMYCIN	Mid Tall Man
azITHROMYCIN	azATHIOPRINE	Mid Tall Man
carbAMAZEPINe	carbIMAZOLe	Mid Tall Man
carbIMAZOLe	carbAMAZEPINe	Mid Tall Man
cefACLOR	cefADROXIL	Mid Tall Man
cefADROXIL	cefACLOR	Mid Tall Man
cefALEXIN	cefTRIAZONE	Mid Tall Man
cefTRIAZONE	cefALEXIN	Mid Tall Man
cefIXime	cefOTAXime	Mid Tall Man
cefOTAXime	cefIXime	Mid Tall Man
cefTAZIDime	cefUROXime	Mid Tall Man
cefUROXime	cefTAZIDime	Mid Tall Man
clomiFEne	clomiPRAMIne	Mid Tall Man
clomiPRAMIne	clomiFEne	Mid Tall Man
Depo-MEDRONE	Depo-PROVERA	Mid Tall Man
Depo-PROVERA	Depo-MEDRONE	Mid Tall Man
doPamine	doBUTamine	Mid Tall Man
doBUTamine	doPamine	Mid Tall Man
diPYRIDAMOLe	diSOPYRAMIDe	Mid Tall Man
diSOPYRAMIDe	diPYRIDAMOLe	Mid Tall Man
folic acid	foliNic acid	Mid Tall Man
foliNic acid	folic acid	Mid Tall Man
gliCLAzide	gliPIzide	Mid Tall Man
gliPIzide	gliCLAzide	Mid Tall Man

mercaptAMine	mercaptOPURine	Mid Tall Man
mercaptOPURine	mercaptAMine	Mid Tall Man
niCARdipine	niFEdipine	Mid Tall Man
niFEdipine	niCARdipine	Mid Tall Man
penicillAMINE	penicillIN	Mid Tall Man
penicillIN	penicillAMINE	Mid Tall Man
pregaBALIN	PregaDAY	Mid Tall Man
PregaDAY	pregaBALIN	Mid Tall Man
RifADIN	RifINAH	Mid Tall Man
RifINAH	RifADIN	Mid Tall Man
vinBLASTine	vinCRISTine	Mid Tall Man
vinCRISTine	vinBLASTine	Mid Tall Man
ZoFRAn	ZoTOn	Mid Tall Man
ZoTOn	ZoFRAn	Mid Tall Man
zoLPIDEM	zoPICLONE	Mid Tall Man
zoPICLONE	zoLPIDEM	Mid Tall Man
azathioPrine	azithroMycin	CD3 Tall Man
azithroMycin	azathioPrine	CD3 Tall Man
carbAmazepine	carbimazOle	CD3 Tall Man
carbimazOle	carbAmazepine	CD3 Tall Man
cefaCLor	cefaDROxil	CD3 Tall Man
cefaDROxil	cefaCLor	CD3 Tall Man
cefaLEXin	cefTRiazone	CD3 Tall Man
cefTRiazone	cefaLEXin	CD3 Tall Man
cefiXime	cefOTAxime	CD3 Tall Man
cefOTAxime	cefiXime	CD3 Tall Man
cefTAZidime	cefUROxime	CD3 Tall Man
cefUROxime	cefTAZidime	CD3 Tall Man
clomiFEne	clomiPRAmine	CD3 Tall Man
clomiPRAmine	clomiFEne	CD3 Tall Man
Depo-MEDrone	Depo-PROvera	CD3 Tall Man
Depo-PROvera	Depo-MEDrone	CD3 Tall Man
doPAMine	doBUTamine	CD3 Tall Man
doBUTamine	doPAMine	CD3 Tall Man
dipyriDamole	disopyRAmide	CD3 Tall Man
disopyRAmide	dipyriDamole	CD3 Tall Man
foLic acid	foliNic acid	CD3 Tall Man
foliNic acid	foLic acid	CD3 Tall Man
gliCLAzide	gliPizide	CD3 Tall Man
gliPizide	gliCLAzide	CD3 Tall Man
mercaptAMine	mercaptoPURine	CD3 Tall Man
mercaptoPURine	mercaptAMine	CD3 Tall Man
niCARdipine	niFEDipine	CD3 Tall Man
niFEDipine	niCARdipine	CD3 Tall Man
penicillAMine	peniciLLin	CD3 Tall Man
peniciLLin	penicillAMine	CD3 Tall Man
pregaBalin	PregaDay	CD3 Tall Man
PregaDay	pregaBalin	CD3 Tall Man
RifaDin	RifiNah	CD3 Tall Man
RifiNah	RifaDin	CD3 Tall Man
vinBLAstine	vinCRistine	CD3 Tall Man
vinCRistine	vinBLAstine	CD3 Tall Man
ZoFRan	ZoTon	CD3 Tall Man
ZoTon	ZoFRan	CD3 Tall Man

zolpiDem	zopiCLone	CD3 Tall Man
zopiCLone	zolpiDem	CD3 Tall Man
azaTHIOprine	aziTHROmycin	Wild Tall Man
aziTHROmycin	azaTHIOprine	Wild Tall Man
carBAMAZepine	carBIMazole	Wild Tall Man
carBIMazole	carBAMAZepine	Wild Tall Man
cefACLOR	cefADROXIL	Wild Tall Man
cefADROXIL	cefACLOR	Wild Tall Man
cefALEXIN	cefTRIAZONE	Wild Tall Man
cefTRIAZONE	cefALEXIN	Wild Tall Man
ceflXime	cefOTAXime	Wild Tall Man
cefOTAXime	ceflXime	Wild Tall Man
cefTAZIDime	cefUROXime	Wild Tall Man
cefUROXime	cefTAZIDime	Wild Tall Man
clomiFENE	clomiPRAMINE	Wild Tall Man
clomiPRAMINE	clomiFENE	Wild Tall Man
Depo-MEDRONE	Depo-PROVERA	Wild Tall Man
Depo-PROVERA	Depo-MEDRONE	Wild Tall Man
DOPamine	DOBUTamine	Wild Tall Man
DOBUTamine	DOPamine	Wild Tall Man
diPYRIDAMOLE	diSOPYRAMIDE	Wild Tall Man
diSOPYRAMIDE	diPYRIDAMOLE	Wild Tall Man
foliC acid	foliNIC acid	Wild Tall Man
foliNIC acid	foliC acid	Wild Tall Man
gliCLAzide	glipiZIDE	Wild Tall Man
glipiZIDE	gliCLAzide	Wild Tall Man
mercaptAMINE	mercaptOPURINE	Wild Tall Man
mercaptOPURINE	mercaptAMINE	Wild Tall Man
NICARdipine	NIFEdipine	Wild Tall Man
NIFEdipine	NICARdipine	Wild Tall Man
peniciLLAMINE	peniciLLIN	Wild Tall Man
peniciLLIN	peniciLLAMINE	Wild Tall Man
PregABALIN	PregADAY	Wild Tall Man
PregADAY	PregABALIN	Wild Tall Man
RifADIN	RiflNAH	Wild Tall Man
RiflNAH	RifADIN	Wild Tall Man
vinBLAStine	vinCRIStine	Wild Tall Man
vinCRIStine	vinBLAStine	Wild Tall Man
ZoFRAN	ZoTON	Wild Tall Man
ZoTON	ZoFRAN	Wild Tall Man
zoLPIDEM	zoPICLONE	Wild Tall Man
zoPICLONE	zoLPIDEM	Wild Tall Man

The stimulus set used in the Pick List Experiment

Medicine name in textual format	Textual format	Dosage and formulation
Azathioprine	NATURAL	50mg tablets
Azithromycin	NATURAL	250mg tablets
carbamazepine	NATURAL	200mg tablets
Carbimazole	NATURAL	20mg tablets
Cefaclor	NATURAL	250mg capsules
Cefadroxil	NATURAL	500mg capsules
Cefalexin	NATURAL	250mg capsules
Cefixime	NATURAL	200mg tablets
Cefotaxime	NATURAL	1g injection
Ceftazidime	NATURAL	1g injection
Ceftriazone	NATURAL	1g injection
Cefuroxime	NATURAL	1.5g injection
Clomifene	NATURAL	50mg tablet
Clomipramine	NATURAL	10mg capsules
Depo-medrone	NATURAL	3ml 40mg in 1ml injection
Depo-provera	NATURAL	500mg injection
Dipyridamole	NATURAL	retard 200mg modified release capsule
Disopyramide	NATURAL	100mg capsules
Dobutamine	NATURAL	250mg in 5ml injection
Dopamine	NATURAL	200mg in 5ml injection
folic acid	NATURAL	15mg in 1ml injection
folinic acid	NATURAL	15mg in 2ml injection
Gliclazide	NATURAL	80mg tablets
Glipizide	NATURAL	5mg tablets
mercaptamine	NATURAL	50mg capsules
mercaptopurine	NATURAL	10mg capsules
Nicardipine	NATURAL	30mg capsules
Nifedipine	NATURAL	5mg capsules
Nimodipine	NATURAL	30mg tablets
Penicillamine	NATURAL	250 mg tablets
Penicillin	NATURAL	v 250 mg tablets
Pregabalin	NATURAL	75mg capsules
Pregaday	NATURAL	tablets
Rifadin	NATURAL	150mg capsules
Rifinah	NATURAL	150 tablets
Vinblastine	NATURAL	10mg in 10ml injection
Vincristine	NATURAL	1mg in 1ml injection
Vindesine	NATURAL	5mg injection
Zofran	NATURAL	8mg tablets
Zolpidem	NATURAL	5mg tablets
Zopiclone	NATURAL	7.5mg tablets
Zoton	NATURAL	15mg capsules
AZATHIOPRINE	UPPERCASE	50mg tablets
AZITHROMYCIN	UPPERCASE	250mg tablets
CARBAMAZEPINE	UPPERCASE	200mg tablets
CARBIMAZOLE	UPPERCASE	20mg tablets
CEFACLOR	UPPERCASE	250mg capsules
CEFADROXIL	UPPERCASE	500mg capsules
CEFALEXIN	UPPERCASE	250mg capsules

CEFIXIME	UPPERCASE	200mg tablets
CEFOTAXIME	UPPERCASE	1g injection
CEFTAZIDIME	UPPERCASE	1g injection
CEFTRIAZONE	UPPERCASE	1g injection
CEFUROXIME	UPPERCASE	1.5g injection
CLOMIFENE	UPPERCASE	50mg tablet
CLOMIPRAMINE	UPPERCASE	10mg capsules
DEPO-MEDRONE	UPPERCASE	3ml 40mg in 1ml injection
DEPO-PROVERA	UPPERCASE	500mg injection
DIPYRIDAMOLE	UPPERCASE	retard 200mg modified release capsule
DISOPYRAMIDE	UPPERCASE	100mg capsules
DOBUTAMINE	UPPERCASE	250mg in 5ml injection
DOPAMINE	UPPERCASE	200mg in 5ml injection
FOLIC ACID	UPPERCASE	15mg in 1ml injection
FOLINIC ACID	UPPERCASE	15mg in 2ml injection
GLICLAZIDE	UPPERCASE	80mg tablets
GLIPIZIDE	UPPERCASE	5mg tablets
MERCAPTAMINE	UPPERCASE	50mg capsules
MERCAPTOPURINE	UPPERCASE	10mg capsules
NICARDIPINE	UPPERCASE	30mg capsules
NIFEDIPINE	UPPERCASE	5mg capsules
NIMODIPINE	UPPERCASE	30mg tablets
PENICILLAMINE	UPPERCASE	250 mg tablets
PENICILLIN	UPPERCASE	v 250 mg tablets
PREGABALIN	UPPERCASE	75mg capsules
PREGADAY	UPPERCASE	tablets
RIFADIN	UPPERCASE	150mg capsules
RIFINAH	UPPERCASE	150 tablets
VINBLASTINE	UPPERCASE	10mg in 10ml injection
VINCRISTINE	UPPERCASE	1mg in 1ml injection
VINDESINE	UPPERCASE	5mg injection
ZOFRAN	UPPERCASE	8mg tablets
ZOLPIDEM	UPPERCASE	5mg tablets
ZOPICLONE	UPPERCASE	7.5mg tablets
ZOTON	UPPERCASE	15mg capsules
azATHIOPRINE	MID TALL MAN	50mg tablets
azITHROMYCIN	MID TALL MAN	250mg tablets
carbAMAZEPINe	MID TALL MAN	200mg tablets
carbIMAZOLe	MID TALL MAN	20mg tablets
cefACLOR	MID TALL MAN	250mg capsules
cefADROXIL	MID TALL MAN	500mg capsules
cefALEXIN	MID TALL MAN	250mg capsules
ceflXime	MID TALL MAN	200mg tablets
cefOTAXime	MID TALL MAN	1g injection
cefTAZIDime	MID TALL MAN	1g injection
cefTRIAZONE	MID TALL MAN	1g injection
cefUROXime	MID TALL MAN	1.5g injection
clomiFEne	MID TALL MAN	50mg tablet
clomiPRAMIne	MID TALL MAN	10mg capsules
Depo-MEDRONE	MID TALL MAN	3ml 40mg in 1ml injection
Depo-PROVERA	MID TALL MAN	500mg injection
diPYRIDAMOLe	MID TALL MAN	retard 200mg modified release capsule
diSOPYRAMIDe	MID TALL MAN	100mg capsules
doBUTamine	MID TALL MAN	250mg in 5ml injection

doPamine	MID TALL MAN	200mg in 5ml injection
folic acid	MID TALL MAN	15mg in 1ml injection
foliNic acid	MID TALL MAN	15mg in 2ml injection
gliCLAzide	MID TALL MAN	80mg tablets
gliPIzide	MID TALL MAN	5mg tablets
mercaptAMine	MID TALL MAN	50mg capsules
mercaptOPURine	MID TALL MAN	10mg capsules
niCARdipine	MID TALL MAN	30mg capsules
niFEdipine	MID TALL MAN	5mg capsules
niMOdipine	MID TALL MAN	30mg tablets
penicillAMINE	MID TALL MAN	250 mg tablets
penicillIN	MID TALL MAN	v 250 mg tablets
pregaBALIN	MID TALL MAN	75mg capsules
PregaDAY	MID TALL MAN	tablets
RifADIN	MID TALL MAN	150mg capsules
RifINAH	MID TALL MAN	150 tablets
vinBLASTine	MID TALL MAN	10mg in 10ml injection
vinCRISTine	MID TALL MAN	1mg in 1ml injection
vinDESine	MID TALL MAN	5mg injection
ZoFRAn	MID TALL MAN	8mg tablets
zoLPIDEM	MID TALL MAN	5mg tablets
zoPICLONE	MID TALL MAN	7.5mg tablets
ZoTOn	MID TALL MAN	15mg capsules
azathioPrine	CD3 TALL MAN	50mg tablets
azithroMycin	CD3 TALL MAN	250mg tablets
carbAmazepine	CD3 TALL MAN	200mg tablets
carbimazOle	CD3 TALL MAN	20mg tablets
cefaCLor	CD3 TALL MAN	250mg capsules
cefaDROxil	CD3 TALL MAN	500mg capsules
cefaLEXin	CD3 TALL MAN	250mg capsules
cefiXime	CD3 TALL MAN	200mg tablets
cefOTAxime	CD3 TALL MAN	1g injection
cefTAZidime	CD3 TALL MAN	1g injection
cefTRiazone	CD3 TALL MAN	1g injection
cefUROxime	CD3 TALL MAN	1.5g injection
clomiFEne	CD3 TALL MAN	50mg tablet
clomiPRAmine	CD3 TALL MAN	10mg capsules
Depo-MEDrone	CD3 TALL MAN	3ml 40mg in 1ml injection
Depo-PROvera	CD3 TALL MAN	500mg injection
dipyriDamole	CD3 TALL MAN	retard 200mg modified release capsule
disopyRAmide	CD3 TALL MAN	100mg capsules
doBUTamine	CD3 TALL MAN	250mg in 5ml injection
doPAMine	CD3 TALL MAN	200mg in 5ml injection
foLic acid	CD3 TALL MAN	15mg in 1ml injection
foliNic acid	CD3 TALL MAN	15mg in 2ml injection
gliCLAzide	CD3 TALL MAN	80mg tablets
gliPizide	CD3 TALL MAN	5mg tablets
mercaptAMine	CD3 TALL MAN	50mg capsules
mercaptoPURine	CD3 TALL MAN	10mg capsules
niCARdipine	CD3 TALL MAN	30mg capsules
niFEDipine	CD3 TALL MAN	5mg capsules
niModipine	CD3 TALL MAN	30mg tablets
penicillAMine	CD3 TALL MAN	250 mg tablets
peniciLLin	CD3 TALL MAN	v 250 mg tablets

pregaBalin	CD3 TALL MAN	75mg capsules
PregaDay	CD3 TALL MAN	tablets
RifaDin	CD3 TALL MAN	150mg capsules
RifiNah	CD3 TALL MAN	150 tablets
vinBLAstine	CD3 TALL MAN	10mg in 10ml injection
vinCRistine	CD3 TALL MAN	1mg in 1ml injection
vinDESine	CD3 TALL MAN	5mg injection
ZoFRan	CD3 TALL MAN	8mg tablets
zolpiDem	CD3 TALL MAN	5mg tablets
zopiCLone	CD3 TALL MAN	7.5mg tablets
ZoTon	CD3 TALL MAN	15mg capsules
azaTHIOprine	WILD TALL MAN	50mg tablets
aziTHROmycin	WILD TALL MAN	250mg tablets
carBAMAZepine	WILD TALL MAN	200mg tablets
carBIMazole	WILD TALL MAN	20mg tablets
cefACLOR	WILD TALL MAN	250mg capsules
cefADROXIL	WILD TALL MAN	500mg capsules
cefALEXIN	WILD TALL MAN	250mg capsules
cefIXime	WILD TALL MAN	200mg tablets
cefOTAXime	WILD TALL MAN	1g injection
cefTAZIDime	WILD TALL MAN	1g injection
cefTRIAZONE	WILD TALL MAN	1g injection
cefUROXime	WILD TALL MAN	1.5g injection
clomiFENE	WILD TALL MAN	50mg tablet
clomiPRAMINE	WILD TALL MAN	10mg capsules
Depo-MEDRONE	WILD TALL MAN	3ml 40mg in 1ml injection
Depo-PROVERA	WILD TALL MAN	500mg injection
diPYRIDAMOLe	WILD TALL MAN	retard 200mg modified release capsule
diSOPYRAMIDe	WILD TALL MAN	100mg capsules
DOBUTamine	WILD TALL MAN	250mg in 5ml injection
DOPamine	WILD TALL MAN	200mg in 5ml injection
foliC acid	WILD TALL MAN	15mg in 1ml injection
foliNIC acid	WILD TALL MAN	15mg in 2ml injection
gliCLAzide	WILD TALL MAN	80mg tablets
glipiZIDE	WILD TALL MAN	5mg tablets
mercaptAMINE	WILD TALL MAN	50mg capsules
mercaptOPURINE	WILD TALL MAN	10mg capsules
NICARdipine	WILD TALL MAN	30mg capsules
NIFEdipine	WILD TALL MAN	5mg capsules
niMOdipine	WILD TALL MAN	30mg tablets
peniciLLAMINE	WILD TALL MAN	250 mg tablets
peniciLLIN	WILD TALL MAN	v 250 mg tablets
PregABALIN	WILD TALL MAN	75mg capsules
PregADAY	WILD TALL MAN	tablets
RifADIN	WILD TALL MAN	150mg capsules
RifINAH	WILD TALL MAN	150 tablets
vinBLAStine	WILD TALL MAN	10mg in 10ml injection
vinCRIStine	WILD TALL MAN	1mg in 1ml injection
vinDEsine	WILD TALL MAN	5mg injection
ZoFRAN	WILD TALL MAN	8mg tablets
zoLPIDEM	WILD TALL MAN	5mg tablets
zoPICLONE	WILD TALL MAN	7.5mg tablets
ZoTON	WILD TALL MAN	15mg capsules

Distractor items in the Pick List experiment with experimental medicine names intermingled.

Medicine name	Dosage and formulation
amikacin	in sodium chloride 0.9% 700mg in 250ml infusion
amikacin	in sodium chloride 0.9% 800mg in 250ml infusion
amikacin	in sodium chloride 0.9% 900mg in 250ml infusion
amiloride	5mg in 5ml oral solution
amiloride	5mg tablets
amino acid mix	complete code 124 (whole) powder
aminophylline	(norphyllin) 225mg modified release tablets
aminophylline	(phyllocontin) 225mg modified release tablets
aminophylline	100mg modified release tablets
amitriptyline	25mg in 5ml syrup
amitriptyline	25mg tablets
amitriptyline	50mg tablets
amlodipine	10mg tablets
amlodipine	5mg tablets
amnicator	stick
amobarbital	200mg capsules
amobarbital	60mg capsules
amorolfine hydrochloride	nail lacquer 5%
azathioprine	25mg tablets
azathioprine	50mg injection
azathioprine	50mg tablets
azelaic	20% cream
azithromycin	200mg in 5ml powder for oral suspension
azithromycin	250mg capsules
azithromycin	250mg tablets
aztreonam	1g injection
aztreonam	2g injection
carbamazepine	200mg modified release tablets
carbamazepine	200mg tablets
carbamazepine	250mg suppositories
carbamazepine	400mg modified release tablets
carbamazepine	400mg tablets
carbex	granules/solution combined pack
carbimazole	20mg tablets
carbimazole	5mg in 5ml suspension
carbimazole	5mg tablets
cefaclor	250mg capsules
cefaclor	250mg in 5ml suspension
cefaclor	375mg modified release tablets
cefadroxil	125mg in 5ml syrup
cefadroxil	250mg in 5ml syrup
cefadroxil	500mg capsules
cefadroxil	500mg in 5ml syrup
cefadroxil	500mg tto pack 10 capsules
cefadroxil	syrup 250 mg in 5ml tto pack
cefalexin	125mg in 5ml syrup
cefalexin	250mg capsules
cefalexin	250mg tablets
cefalexin	250mg in 5ml syrup

cefalexin	500mg capsules
cefalexin	500mg tablets
cefixime	200mg tablets
cefotaxime	1g injection
cefotaxime	2g injection
cefotaxime	500mg injection
ceftazidime	1g in 100ml sodium chloride 0.9% infusion
ceftazidime	1g injection
ceftazidime	2g in 100ml sodium chloride 0.9% infusion
ceftazidime	2g injection
ceftazidime	500mg injection
ceftriazone	1g injection
ceftriazone	2g injection
ceftriazone	250mg injection
cefuroxime	(preservative free) 5% eye drops
cefuroxime	1.5g injection
cefuroxime	250mg injection
cefuroxime	750mg injection
cefuroxime	axetil 125mg in 5 ml suspension
cefuroxime	axetil 250mg tablets
clofarabine	**aml 16 trial** 20mg vial
clomethiazole	(equiv to 50mg/ml clomethiazole edisilate) 31.5mg in 1ml elixir
clomethiazole	0.8% infusion
clomethiazole	192mg capsules
clomifene	50mg tablet
clomipramine	10mg capsules
clomipramine	25mg capsules
clomipramine	75mg sustained release capsules
clomipramine	75mg sustained release tablets
Depo-Medrone	1ml 40mg in 1ml injection
Depo-Medrone	2ml 40mg in 1ml injection
Depo-Medrone	3ml 40mg in 1ml injection
Depo-Provera	500mg injection
Depo-Provera	100mg tablets
Depo-Provera	200mg tablets
Depo-Provera	250mg tablets
Depo-Provera	400mg tablets
Depo-Provera	5mg tablets
dobutamine	250mg in 20ml injection
dobutamine	250mg in 5ml injection
dobutamine	in dextrose 5% 500mg infusion
dobutamine	in sodium chloride 500mg
dobutamine	250mg in 5ml injection
docetaxel	20mg injection
docetaxel	80mg injection
docusate	100mg capsules
docusate	100mg tto pack 30 capsules
docusate	adult 50mg in 5ml oral solution
docusate	paediatric 12.5mg in 5ml syrup
domperidone	1mg in 1ml suspension
domperidone	10mg tablets
domperidone	30mg suppositories
donepezil	10mg tablets
donepezil	5mg tablets

dopamine	200mg in 5ml injection
dopamine	pre-mix 400mg in 250ml infusion
dopamine	pre-mix 800mg in 250mllnfusion
dopamine	select ajet 800mg in 20ml syringe
dornase alfa	1000 units in 1ml 2.5ml vial
dorzolamide	2% eye drops
dorzolamide	2% single dose eye drops
dipyridamole	50mg in 5ml suspension
dipyridamole	retard 200mg modified release capsule
disodium clodidronate	520mg tablets
disodium edetate	0.38% eye drops
disodium etidronate	400mg with calcium carbonate 1.25g tablets
disodium edentate	0.001m solution
disodium edentate	0.4% eye lotion
disopyramide	100mg capsules
disopyramide	100mg in 100ml sodium chloride 0.9% infusion
folic acid	400 micrograms tablets
folic acid	90's "otc" 400 micrograms tablets
folic acid	15mg in 1ml injection
folic acid	2.5mg in 5ml syrup
folic acid	5mg tablets
folic acid	90's [pre-conceive] otc 400 micrograms tablets
folinic acid	100mg in 10ml injection
folinic acid	15mg in 2ml injection
folinic acid	300mg in 30ml injection
gliclazide	80mg tablets
gliclazide	tablets (60's) 80mg tto pack
glimepiride	1mg tablets
glimepiride	2mg tablets
glimepiride	3mg tablets
glimepiride	4mg tablets
glipizide	2.5mg tablets
glipizide	5mg tablets
hydralazine	100mg in 500ml sodium chloride 0.9% infusion
hydralazine	12.5mg in 5ml suspension
hydralazine	12.5mg tablets
hydralazine	20mg injection
hydralazine	25mg tablets
hydralazine	50mg tablets
hydrochloric acid	(dilute) bpc solution
hydrochlorothiazide	2mg in 1ml suspension
hydrochlorothiazide	50mg tablets
hydroxycarbamide	500mg capsules
hydroxychloroquine	100mg in 5ml suspension
hydroxychloroquine	200mg tablets
hydroxychloroquine	300 mg in 5ml suspension
hydroxychloroquine	75mg in 5ml liquid
hydroxyethyl starch	[voluven) 6% in sodium chloride 0.9% 500ml infusion 500ml
hydroxyzine	10mg in 5ml liquid
hydroxyzine	10mg tablets
hydroxyzine	25mg tablets
mercaptamine	(cysteamine) 75mg oral powder
mercaptamine	150mg capsules
mercaptamine	50mg capsules

mercaptopurine	10mg capsules
mercaptopurine	10mg tablets
mercaptopurine	20mg in 5ml suspension
mercaptopurine	50mg tablets
mercilon	tablets
merocaine	lemon flavour lozenges
nicardipine	20mg capsules
nicardipine	30mg capsules
nicardipine	30mg modified release capsules
nicorandil	10mg tablets
nicorandil	20mg tablets
Nicorette	(7s) *otc* 10mg patch
Nicorette	(7s) *otc* 15mg patch
Nicorette	(7s) *otc* 5mg patch
Nicorette	10mg patch
Nicorette	15mg patch
Nicorette	5mg patch
Nicorette	fresh mint (30’s) *otc* 2mg chewing gum
Nicorette	fresh mint (30’s) *otc* 4mg chewing gum
Nicorette	microtab 2mg microtab
Nicorette	mint (105’s) *otc* 2mg chewing gum
Nicorette	mint (105’s) *otc* 4mg chewing gum
Nicorette	original (105’s) *otc* 2mg chewing gum
Nicorette	original (105’s) *otc* 4mg chewing gum
Nicorette	original (30’s) *otc* 2mg chewing gum
Nicorette	original (30’s) *otc* 4mg chewing gum
Nicorette	original 2mg chewing gum
Nicorette	original 4mg chewing gum
nicotinamide	500mg tablets
Nicotinell	tts 10 **otc** 7mg/24 hours patch
Nicotinell	tts 10 7mg/24 hours patch
Nicotinell	tts 20 7mg/24 hours patch
Nicotinell	tts 20 **otc** 14mg/24hours patch
Nicotinell	tts 20 14mg/24hours patch
Nicotinell	tts 30 **otc** 21mg/24hours patch
Nicotinell	tts 30 (free stock) 21mg/24 hours patch
Nicotinell	tts 30 21mg/24 hours patch
nicotinic acid	500mg modified release tablets
nicotinic acid	starter pack modified release tablets
nifedipine	(coracten sr) 10mg modified release capsules
nifedipine	(coracten sr) 20mg modified release capsules
nifedipine	(coracten xl) 30mg capsules
nifedipine	(coracten xl) 60mg capsules
nifedipine	(tensipine) 20mg modified release tablets
nifedipine	2% (20mg in 1ml) (1mg in 1 drop) drops
nifedipine	5mg capsules
nifedipine	la (adalat la) 20mg modified release tablets
nifedipine	la (adalat la) 30mg modified release tablets
nifedipine	la (adalat la) 60mg modified release tablets
nifedipine	retard (adalat retard) 10mg modified release tablets
Night Nurse	capsules 10's **otc** capsules
Night Nurse	liquid **otc** liquid
night splint	dorsi-wedge large
night splint	dorsi-wedge medium

night splint	dorsi-wedge small
night splint	dorsi-wedge x large
nimodipine	10mg in 50ml infusion
nimodipine	10mg in 50ml infusion
nimodipine	10mg in 50ml pre-filled syringe
nimodipine	30mg tablets
nimodipine	60mg in 10ml suspension
niopam 340	contrast media liquid
Niquitin CQ	mint 2mg lozenges
Niquitin CQ	original 4mg lozenges
nitrazepam	2.5mg in 5ml suspension
nitrazepam	5mg tablets
penicillamine	500 mg tablets
penicillamine	250 mg tablets
penicillin	g benzathine 1.2 mega units vial
penicillin	v 125 mg in 5ml tto pack oral solution
penicillin	v 125mg in 5ml oral solution
penicillin	v 250 mg in 5ml tto pack oral solution
penicillin	v 250 mg tablets
penicillin	v 250 mg tto pack 28 tablets
penicillin	v 250 mg tto pack 40 tablets
pregabalin	155mg capsules
pregabalin	25mg capsules
pregabalin	300mg capsules
pregabalin	50mg capsules
pregabalin	75mg capsules
Pregaday	tablets
pregnancy test	urine
rifampicin	150 mg capsules
rifampicin	300 mg capsules
rifampicin	600mg injection
rifampicin	100mg in 5ml syrup
Rifadin	150mg capsules
Rifadin	300mg capsules
Rifadin	600mg injection
Rifadin	syrup 100mg in 5ml syrup
rifampicin	300mg with isoniazid 150mg tablets
rifampicin	300mg with isoniazid 150mg tablets
Rifinah	150 tablets
Rifinah	300 TTO pack
Rifinah	300 tablets
vinblastine	10mg in 10ml injection
vincristine	1mg in 1ml injection
vincristine	2mg injection
vindesine	5mg injection
vinorelbine	10mg in 1ml injection
vinorelbine	20mg capsules
vinorelbine	30mg capsules
vinorelbine	50mg in 5ml injection
Zofran	8mg tablets
Zofran	4mg in 2ml injection
Zofran	8mg in 4ml injection
Zofran	4mg in 5ml syrup
Zofran	4mg tablets

Zofran	8mg tablets
Zoladex	goserelin 10.8mg injection
Zoladex	goserelin 3.6mg injection
Zoladex	la goserelin 10.8mg injection
Zoladex	la goserelin 3.6mg injection
Zoladex	la (zenec) goserelin 10.8mg injection
Zoladex	la (zenec) goserelin 3.6mg injection
Zolvera	verapamil 5mg in 2ml injection
Zolvera	verapamil 120mg tablets
Zolvera	verapamil 40mg tablets
Zolvera	verapamil 80mg tablets
Zolvera	verapamil 40mg in 5ml oral solution
Zolvera	verapamil 120mg modified release tablets
Zolvera	verapamil 240mg modified release tablets
Zolvera	verapamil 120mg modified release capsules
Zolvera	verapamil 180mg modified release capsules
Zolvera	verapamil 240mg modified release capsules
Zometa	zoledronicacid 4mg infusion
Zometa	zoledronicacid 50 micrograms in 1ml infusion 100ml
Zonegran	zonisamide 25mg capsules
Zonegran	zonisamide 50mg capsules
zopiclone	zop22y zopiclone 3.75 mg tablets
zopiclone	zop22y zopiclone 7.5 mg tablets
Zorec	azarotene 0.05% gel
Zorec	tazarotene 0.1% gel
Zostrix	56g axsai capsaicin 0.025% cream
Zostrix	56g axsai capsaicin 0.075% cream
Zoton	15mg capsules
Zoton	30mg capsules
Zoton	30mg sachets
Zoton	15mg fastab
Zoton	30mg fastab
zoledronic acid	4mg injection
zoledronic acid	4mg infusion
zoledronic acid	50 micrograms in 1ml infusion 100ml
Zolpidem	5mg tablets
zonisamide	25mg capsules
zonisamide	50mg capsules
zopiclone	3.75mg tablets
zopiclone	7.5mg tablets