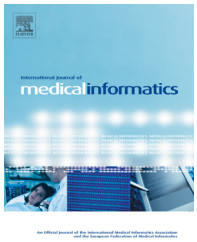
INTERNATIONAL JOURNAL OF MEDICAL INFORMATICS 83 (2014) 368–375

journal homepage: www.ijmijournal.com



Automation bias: Empirical results assessing influencing factors

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ARTICLE INFO

Article history:
Received 4 March 2013
Received in revised form
3 January 2014
Accepted 7 January 2014

Keywords:
Clinical decision support systems
Clinical decision making
Prescribing

ABSTRACT

Objective: To investigate the rate of automation bias – the propensity of people to over rely on automated advice and the factors associated with it. Tested factors were attitudinal – trust and confidence, non-attitudinal – decision support experience and clinical experience, and environmental – task difficulty. The paradigm of simulated decision support advice within a prescribing context was used.

Design: The study employed within participant before–after design, whereby 26 UK NHS General Practitioners were shown 20 hypothetical prescribing scenarios with prevalidated correct and incorrect answers – advice was incorrect in 6 scenarios. They were asked to prescribe for each case, followed by being shown simulated advice. Participants were then asked whether they wished to change their prescription, and the post-advice prescription was recorded.

Measurements: Rate of overall decision switching was captured. Automation bias was measured by negative consultations – correct to incorrect prescription switching.

Results: Participants changed prescriptions in 22.5% of scenarios. The pre-advice accuracy rate of the clinicians was 50.38%, which improved to 58.27% post-advice. The CDSS improved the decision accuracy in 13.1% of prescribing cases. The rate of automation bias, as measured by decision switches from correct pre-advice, to incorrect post-advice was 5.2% of all cases – a net improvement of 8%.

More immediate factors such as trust in the specific CDSS, decision confidence, and task difficulty influenced rate of decision switching. Lower clinical experience was associated with more decision switching.

Age, DSS experience and trust in CDSS generally were not significantly associated with decision switching.

Conclusions: This study adds to the literature surrounding automation bias in terms of its potential frequency and influencing factors.

1. Introduction

Automation bias (AB) – the tendency to over-rely on automation – is an anecdotally prevalent effect with little deliberate, rigorous empirical investigation. In the healthcare domain this effect could lead to serious consequences to patients in terms from harm to fatality, due to misdiagnosis or inaccurate prescribing. In the literature AB can be demonstrated by "negative consultation", a term used to denote when a

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http://dx.doi.org/10.1016/j.ijmedinf.2014.01.001

correct decision is changed to an incorrect one on the basis of incorrect advice, or as a decrease in accuracy with an erroneous intervention, compared to a non-intervention control group. In a recent systematic review [1], the rate of negative consultation ranged from 6 to 11% (in 4 healthcare papers [2–5]), and in an indicative meta-analysis of 4 other healthcare papers [6–9] found that when in error the CDSS increased the risk of an incorrect decision being made by 26%. It must be noted that reliance on CDSS advice can lead to positive outcomes, particularly if the CDSS is 100% reliable, however it can lead to systematic error if a physician switches from a correct to an incorrect decision following a piece of incorrect advice (negative switching).

Medication errors are the third most prevalent types of patient safety errors in England [10] and prescribing error is the biggest cause of medication error [11,12]. Recently the General Medical Council (GMC) commissioned a major report [13] studying prescribing errors in terms of rates and causes. The report found that 11,077 of 124,260 medication orders contained errors – a mean error rate of 8.9%. Almost 2% of the errors were classified as potentially lethal. Errors were made by all grades of doctor with the highest error rate (10.3%) found with junior doctors. Avery et al. [14] found that a pharmacist-led, information technology-based intervention was more effective than simple feedback in reducing the number of patients at risk of measures related to hazardous prescribing and inadequate blood-test monitoring of medicines 6 months after the intervention. Both reports cited decision support as part of a complex intervention (as prescribing errors stem from multifactorial causes) to reduce the risk of prescribing error.

It has been shown that CDSS are consistently effective in the area of prescribing. Pearson [15] carried out a systematic review to evaluate the impact of CDSSs on prescribing practise. In a review of 56 papers (38 addressing initiating, 23 monitoring and three stopping therapy); they noted heterogeneity in study design and outcomes, however 88.5% of studies resulted in at least one positive outcome as a result of CDSS intervention, and 44.1% of studies led to ≥50% statistically significant outcomes (as used by Garg et al. [16]). Durieux et al. [17] carried out a Cochrane review on computerized advice for drug dosage, and found significant benefits, including reduced risk of toxic dose (rate ratio of 0.45) and reduced length of hospital stay (standardized mean difference −0.35 days). However, some studies that have examined the impact of CDSS on prescribing have reported no change in error rates [18], or adverse drug events [19]. Recently in a multicentre study, Avery et al. [20] found that a pharmacist-led information technology intervention (PINCER), composed of feedback, educational outreach, and dedicated support was an effective method for reducing a range of medication errors in general practices with computerized clinical records.

A number of mediators of AB have been posited. For example Lee and Moray [21] identified a trade off between and trust and self-confidence in automation as a primary driver in decision aid reliance; when trust in the automation exceeded self-confidence, the automation was more likely to be used and over-relied on. Experience is also a potential factor. For example, Dreiseitl and Binder [22] observed that in 24% of the cases in which physicians' diagnoses did not match those

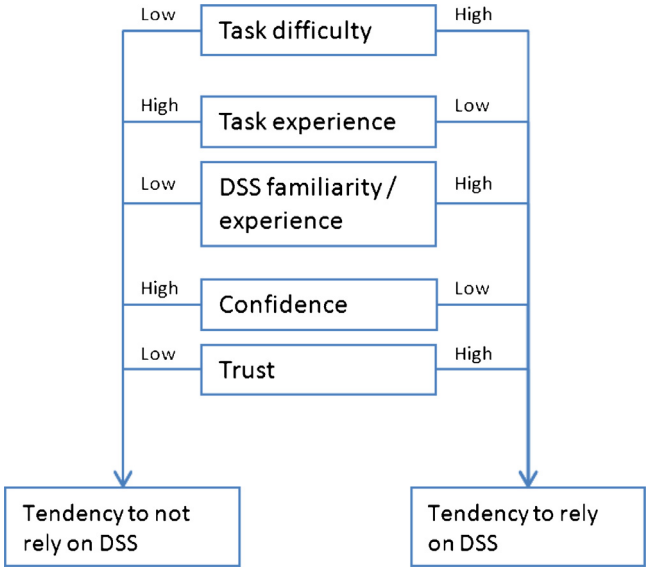

Fig. 1 – Experimental factors.

of the decision support system, the physicians changed their diagnoses. There was a slight but significant negative correlation between susceptibility to change and experience level of the physicians. Lee et al. [23] performed an empirical investigation into the effect of users' DSS expertise on their problem-solving strategies. The results indicated that individuals who had only recently learned to use the DSS were confused or restricted by the set of functions provided by the system and did not use the DSS appropriately. The tendency to over rely is also affected by task difficulty; task difficulty has been found to increase reliance on decision aids [24] – as task difficulty increases to reach the user's cognitive capacity, aid from external resources is increasingly, and potentially erroneously relied on.

Various pre-existing models of reliance allude to the concept of AB. The Theory of Technology Dominance [25] (TDD), for example, proposes several salient influencing factors, implying that overreliance can occur when the decision maker is low in task experience, and there is also a higher level of task complexity. DSS familiarity is posited to encourage appropriate reliance. The model in this paper is based on a literature review to investigate the most prominent influencing factors, which are outlined in Fig. 1.

1.1. *Aim*

This study aimed to investigate the rate of AB in a prescribing situation, at the CDSS reliability rate of 70%, and also the effect of potential mediating factors such as attitudinal factors (trust and confidence), non-attitudinal factors (DSS and clinical experience), and environmental factors (task difficulty).

2. Methods

2.1. *Design*

The experimental paradigm was within participant before–after design. All participants were asked for age,