



Allan, J. L., Johnston, D. W., Powell, D. J. H., Farquharson, B., Jones, M. C., Leckie, G., & Johnston, M. (2019). Clinical decisions and time since rest break: An analysis of decision fatigue in nurses. *Health Psychology, 38*(4), 318-324. <https://doi.org/10.1037/hea0000725>

Peer reviewed version

License (if available):  
Other

Link to published version (if available):  
[10.1037/hea0000725](https://doi.org/10.1037/hea0000725)

[Link to publication record in Explore Bristol Research](#)  
PDF-document

This is the accepted author manuscript (AAM). The final published version (version of record) is available online via the American Psychological Association at <http://dx.doi.org/10.1037/hea0000725> . Please refer to any applicable terms of use of the publisher.

## University of Bristol - Explore Bristol Research

### General rights

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available: <http://www.bristol.ac.uk/red/research-policy/pure/user-guides/ebr-terms/>

1 **Clinical decisions and time since rest break: An analysis of**  
2 **decision fatigue in nurses**

3  
4  
5 Julia L. Allan<sup>1\*</sup>  
6 Derek W. Johnston<sup>1</sup>  
7 Daniel J. H. Powell<sup>1,2</sup>  
8 Barbara Farquharson<sup>3</sup>  
9 Martyn C. Jones<sup>4</sup>  
10 George Leckie<sup>5</sup>  
11 Marie Johnston<sup>1</sup>  
12

13 1. Institute of Applied Health Sciences, University of Aberdeen, Aberdeen,  
14 UK.

15 2. Rowett Institute, University of Aberdeen, Aberdeen, UK

16 3. School of Nursing, Midwifery & Social Care, Edinburgh Napier University,  
17 Edinburgh, UK.

18 4. School of Nursing & Health Sciences, University of Dundee, Dundee, UK.

19 5. Centre for Multilevel Modelling, University of Bristol, Bristol, UK.  
20

21  
22 \*Corresponding author

23 Dr Julia Allan

24 Health Psychology,

25 Institute of Applied Health Sciences,

26 Health Sciences Building,

27 School of Medicine, Medical Sciences & Nutrition,

28 University of Aberdeen,

29 Foresterhill,

30 Aberdeen,

31 AB25 2ZD.

32  
33 +44(0)1224 438103

34 [j.allan@abdn.ac.uk](mailto:j.allan@abdn.ac.uk)  
35  
36

37 **Acknowledgements:** The parent study was funded by the Scottish  
38 Government's Chief Scientist Office (CZH/4/394).  
39

40 **Conflicts of Interest:** None of the authors have conflicts of interest to  
41 declare.  
42  
43

44

45

46

47

48 **ABSTRACT**

49

50 **Objective:** The present study investigates whether nurses working for a  
51 national medical telephone helpline show evidence of 'decision fatigue', as  
52 measured by a shift from effortful to easier and more conservative decisions  
53 as the time since their last rest break increases.

54

55 **Methods:** In an observational, repeated-measures study, data from ~4,000  
56 calls to 150 nurses working for the Scottish NHS 24 medical helpline (37% of  
57 the national workforce) were modelled to determine whether the likelihood of  
58 a nurse deciding to refer a patient to another health professional the same  
59 day (the clinically safest, but most conservative and resource inefficient  
60 decision) varied according to the number of calls taken/time elapsed since a  
61 nurse's last rest break and/or since the start of shift. Analyses used mixed-  
62 effect logistic regression.

63

64 **Results:** For every consecutive call taken since last rest break, the odds of  
65 nurses making a conservative management decision (i.e. arranging for callers  
66 to see another health professional the same day), increased by 5.5% ( $p=.001$ ,  
67 95% CI: 2.2%, 8.8%), an increase in odds of 20.5% per work hour ( $p<.001$ ,  
68 95% CI: 9.1%, 33.2%) or 49.0% (on average) from immediately after one  
69 break to immediately before the next. Decision making was not significantly  
70 related to general or cumulative workload (calls or time elapsed since start of  
71 shift).

72

73 **Conclusions:** Every consecutive decision that nurses make since their last  
74 break produces a predictable shift towards more conservative, and less  
75 resource efficient decisions. Theoretical models of cognitive fatigue can  
76 elucidate how and why this shift occurs, helping to identify potentially  
77 modifiable determinants of patient care.

78

79 **Keywords:** decision making; fatigue; clinical decisions; nurses; efficiency

80

81

82

83 **INTRODUCTION**

84

85

86 *“We think, each of us, that we're much more rational than we are. And we*  
87 *think that we make our decisions because we have good reasons to make*  
88 *them.” Daniel Kahneman (2012)*

89

90

91 In order to make decisions about patients, health professionals must take in  
92 and weigh up relevant information and make a choice about the most  
93 appropriate course of action to take. While it is tempting to believe that the  
94 decisions of health professionals are based entirely on logic and a balanced  
95 weighing of the information available, human decision-making is susceptible  
96 to a wide range of individual, social and environmental influences. In a highly-  
97 cited study of judicial decisions, Danziger, Levav and Avnaim-Pesso (2011)  
98 studied the parole decisions of court judges over the course of the working  
99 day. While the probability of a judge deciding to release a prisoner on parole  
100 at the beginning of the day was ~65%, this fell steadily to nearly 0% as time  
101 since the start of the court session wore on, returning to ~65% after a  
102 food/rest break and again falling steadily to 0% towards the end of the day.

103 The pattern reported fits with the psychological phenomenon '*decision*  
104 *fatigue*': a state occurring when mental resources become depleted and/or  
105 when motivation to exert mental effort declines over time resulting in a  
106 measurable shift towards easier, safer, or more gratifying decisions and  
107 actions (Pignatiello, Martin & Hickman, 2018). In the judge's case, the 'safest'

108 and therefore mentally easiest option was to maintain the status quo (denying  
109 parole); the more depleted judges became, the more likely they were to select  
110 this conservative option until an opportunity arose (in the form of a break) to  
111 rest and replenish their resources. Since its publication, re-analyses of the  
112 original data and data simulation studies have suggested that non-random  
113 ordering of cases before judges and/or explicit planning of cases around  
114 breaks is likely to explain some or all of the observed effects (Weinshall-  
115 Margel & Shapard, 2011; Glockner, 2016). However, the decision fatigue  
116 phenomenon has been observed in multiple contexts where such factors are  
117 less likely to be an issue.

118 Exertion-based depletion effects were first observed more than a  
119 century ago with Arai (1912) noting in a study of continuous work over time  
120 that “.....continued work brings about a decrease in the efficiency of the  
121 [mental] function exercised” (p. 114). Depletion effects are evident in a wide  
122 range of contexts with people being, for example, more likely to cheat at  
123 effortful tasks late in the day (Kouchaki & Smith, 2014), more likely to give up  
124 on diets at the end of the day (McKee, Ntoumani & Taylor, 2014), more likely  
125 to accept default options at the end of a series of consecutive decisions  
126 (Levav, Heitmann, Hermann & Iyengar, 2010) and less able to perform well on  
127 cognitive tests later in the day (Sievertsen, Gino & Piovesan, 2016). Within  
128 the healthcare context, compliance with hand hygiene protocols declines  
129 predictably from the start to the end of shifts (Dai, Milkman, Hofmann &  
130 Staats, 2015; Chudleigh, Fletcher & Gould, 2005), gastroenterologists are  
131 more likely to detect polyps during morning than afternoon colonoscopies  
132 (Chan, Cohen, & Spiegel, 2009), and doctors prescribe more unnecessary

133 antibiotics towards the end than the start of clinic sessions (Linder, Doctor,  
134 Friedberg, Reyes Nieva, Birks, Meeker & Fox, 2014).

135         These decision fatigue effects have been primarily conceptualized as  
136 either the result of 'ego depletion', that is a decrease in the availability of the  
137 mental resources required to exert effortful self-control ( Baumeister,  
138 Pratlavsky, Muraven & Tice, 1998; Baumeister, 2002), or of a progressive  
139 reduction in the motivation required to continue expending effort on the same  
140 task (Inzlicht & Schmeichel, 2012; Inzlicht, Schmeichel & Macrae, 2014;  
141 Kurzban, Duckworth, Kable & Myers, 2013). Recent registered replication  
142 reports (i.e. collections of independently conducted direct replications which  
143 follow an identical protocol) find no evidence of the former, self-control  
144 specific, ego-depletion effect (Hagger, Chatzisarantis, Alberts, Anggono,  
145 Batailler et al, 2016), but, as outlined above, many observational studies  
146 demonstrate predictable changes in behaviour and decision-making over time  
147 that are compatible with the motivational account (Danziger et al, 2011;  
148 Sievertsen et al, 2016; Dai et al, 2015). Within the context of nursing,  
149 research which directly contrasts these opposing accounts of fatigue finds  
150 motivational factors (perceived reward, perceived control) but not indicators of  
151 remaining resource (energy expenditure, work demands) to be consistently  
152 related to subjectively experienced fatigue over the working day (Johnston,  
153 Allan, Powell, Jones, Farquharson et al, 2018). However, this work looks only  
154 at the subjective fatigue reported by nurses and not at any potentially clinically  
155 relevant consequences of that fatigue.

156         Both resource and motivational models would predict that decision  
157 fatigue should arise as a result of progressive increases in uninterrupted 'time

158 on task' and consequently, that fatigue effects would be apparent in situations  
159 where consecutive decisions are made without a break. Large numbers of  
160 consecutive decisions are made in frontline healthcare services where health  
161 professionals must make appropriate diagnostic and treatment decisions  
162 about a series of patients in turn. Consequently, any systematic changes in  
163 decision processes within this context would have clear implications for  
164 service provision (Pignatiello, Martin & Hickman Jr, 2018). Furthermore, as  
165 the most important predictors of patient outcomes in any clinical context are  
166 likely to be fixed (e.g. severity of health condition), identifying new and  
167 potentially modifiable theoretical determinants of these outcomes is important.

168         The present paper investigates the presence and extent of decision  
169 fatigue effects in the healthcare context, specifically testing whether the  
170 number of decisions made by health professionals since a break is, as  
171 predicted by theory, associated with a predictable shift towards more  
172 conservative (and therefore more expensive and less efficient) decisions. The  
173 study focuses on nurses working for the NHS 24 telephone helpline, an NHS  
174 Scotland wide service in which nurses assess callers' reported symptoms,  
175 make decisions about the most appropriate course of action to take, and  
176 direct callers onto primary or secondary care services where required. NHS  
177 24 nurses deal with large numbers of cases and make many decisions each  
178 day. Importantly for the current research, unlike the judges in Danziger et al's  
179 study, nurses in the present study had no control over, or advance knowledge  
180 of, the content of incoming calls and limited control over the timing of their  
181 breaks, enabling a more robust test of the decision fatigue hypothesis. Using  
182 data from ~4,000 real clinical decisions made by 150 nurses, the likelihood of



183 different decisions occurring is modelled from the beginning of a shift, up to  
184 and following breaks during each shift. In line with theoretical accounts of  
185 decision fatigue, it is expected that nurses will become increasingly likely to  
186 make 'safer' and 'easier' (i.e. more conservative) treatment and management  
187 decisions the more decisions they have made since their last break.

188

189 The present study tests two hypotheses. The **decision fatigue hypothesis**  
190 predicts that nurses will become increasingly likely to make conservative  
191 decisions the more uninterrupted time they have spent 'on task' within each  
192 work shift. If this hypothesis is correct, nurses should make increasingly  
193 conservative decisions the more consecutive decisions they have made  
194 and/or the more time that has passed *since their last break* (or in the case of  
195 the period prior to the first break of day, since they started their shift). A critical  
196 prediction of this hypothesis is that any shift in decision making will occur as a  
197 function of time/decisions since last break rather than time elapsed/decisions  
198 made in total over the working day as breaks represent the theorised  
199 opportunity to replenish motivational and/or cognitive resources. To confirm  
200 that any effect detected relates specifically to time/decisions *since break*, a  
201 second hypothesis -the **general work hypothesis** -is also tested to determine  
202 whether decision making changes predictably over the working day as whole  
203 irrespective of opportunities to replenish motivational and/or cognitive  
204 resources (i.e. breaks). If this general hypothesis is correct, nurses should  
205 become increasingly likely to make conservative decisions the more  
206 consecutive decisions they have made and/or the more time that has passed

207 in total *since the start of their shift* (regardless of breaks or time spent 'off-  
208 task').

209

210 Each hypothesis is tested in our models with both number of decisions and  
211 time elapsed as predictors. This results in four planned analyses. Specifically,  
212 the likelihood that nurses would direct callers to another health professional  
213 within 12 hours (the most conservative decision) is modelled in relation to (1)  
214 the number of consecutive decisions made/calls taken since the last break (or  
215 start of shift if prior to first break), (2) time since last break (or start of shift if  
216 prior to first break), (3) decisions made/calls taken in total since the start of  
217 shift regardless of breaks, and (4) total time spent at work since the start of  
218 shift regardless of breaks.

219

220

## 221 **METHODS**

222

### 223 **Design and setting**

224

225 In a within-person, repeated measures study, data were collected on the  
226 timing and number of calls and decisions made by nurses assessing callers to  
227 the NHS 24 telephone service. NHS 24 is a nurse-led telephone (and now  
228 online) advice service operating across Scotland and designed to provide >5  
229 million members of the public with 24 hour access, 365 days a year, to health  
230 services and information. Data for the present study were collected during a  
231 comprehensive evaluation of the possible determinants and consequences of

232 stress in nurses working for the NHS 24 service between 2008 and 2010. The  
233 original parent study included physiological, behavioural and cognitive  
234 measures collected in real time over two full working shifts in addition to  
235 information about the calls received by nurses during the measurement  
236 period. The study protocol (Allan, Farquharson, Choudhary, Johnston, Jones  
237 & Johnston, 2009) gives full details of these measures. Only methodological  
238 information of relevance to the present study is presented here. The study  
239 was reviewed and ethically approved by the NHS North of Scotland Research  
240 Ethics Committee (05/S0801/136).

241

#### 242 **Participants and recruitment**

243 All 465 nurses working in the four main NHS 24 call centres nationally or in  
244 any of the 11 associated integrated local call centres were contacted with  
245 study information and invited to take part in the study. Those interested in  
246 participating ( $n=171$  / 37% of the national workforce) returned a signed  
247 consent form and arranged suitable shifts for participation. Four participants  
248 were excluded (as they were taking medication that would interfere with heart  
249 rate recordings taken in the main study), two participants withdrew, it was not  
250 possible to schedule data collection with thirteen further participants and data  
251 was not available for an additional two participants. This resulted in a final  
252 sample of 150 participants ( $M$  age = 44 years,  $SD = 7.5$ ). Most participants  
253 were female ( $n = 142$ , representative of the gender split in this workforce) and  
254 were employed in seven different call centres across Scotland. Participants  
255 worked an average of 22.6 hours per week ( $SD = 10.4$ ), had been qualified for  
256 an average of 21 years ( $SD = 8.3$ ) and had been employed by NHS 24 for an

257 average of 3.5 years ( $SD = 2.6$ ).

258

## 259 **Procedure**

260 Participating nurses were asked to identify two 'typical' shifts from their next  
261 month's rota where they would be available for participation and where they  
262 would not be engaging in any non-standard activities (e.g. training, away days  
263 etc). Data were collected on all calls received by each of the 150 participating  
264 nurses over these two full working shifts. Call timing (time of day at which call  
265 was taken) and duration (length of call in minutes/seconds) were  
266 automatically recorded, and call outcomes (ambulance call-out, GP referral,  
267 self-care, information provided, etc. see Table 1) were recorded by the nurse.  
268 Most calls to the service are incoming (i.e. a standard call received from a  
269 member of the public who has dialled the service or been routed from their  
270 GPs number). However, during times of peak demand, urgent calls are  
271 prioritised and less urgent calls are queued and returned by nurses later,  
272 resulting in outgoing calls. Outgoing calls were excluded from the present  
273 analysis as in these cases, nurses know in advance that the call is likely to be  
274 non-urgent. Decision making within the service is supported by computerized  
275 decision algorithms which highlight additional questions that nurses may wish  
276 to ask /conditions that should be considered in response to particular  
277 symptoms but in each case, the final decision on treatment / management is  
278 made by an individual nurse.

279

## 280 **Data Coding**

281 Call outcomes - decisions taken by the nurse on which service the patient is

282 referred to and with what level of urgency - were classified as either  
283 conservative (i.e. clinically safest and cognitively easier decisions) or not. All  
284 decisions where the patient was advised to urgently seek, or was directly  
285 referred to primary or secondary care within 12 hours via an urgent as  
286 opposed to routine pathway were conceptualized as the conservative option:  
287 in these cases, callers would be assessed by at least two health professionals  
288 (the NHS 24 nurse and a primary/secondary care practitioner/first responder)  
289 within the same day. As patients in these cases are retained within the  
290 healthcare system and are assessed via phone and then again face to face  
291 the same day, this was deemed the safest option clinically. Such decisions  
292 are also cognitively 'easier' as nurses do not need to offer detailed information  
293 or instructions to the patient, can resolve any uncertainty they feel about the  
294 best course of action and can handover final responsibility for treatment and  
295 management decisions to another health professional. These calls were  
296 compared to all other calls where outcomes reflected less conservative  
297 courses of action (where callers were not retained continuously in the  
298 healthcare system but were advised to seek primary or secondary care 'within  
299 36 hours', or 'at their leisure').

300

301 Breaks from work were classified as any continuous period of 15 minutes or  
302 more between consecutive calls as this reflects the minimum standard break  
303 length within the NHS 24 service. Outside of official breaks, nurses are  
304 required to remain at their stations so that they are 'available for call' and  
305 consequently during these times are unlikely to be truly 'off-task'. The position  
306 of each call within the sequence of calls received since (i) start of shift; and (ii)

307 the last break was computed as the predictor of interest.

308

### 309 **Analysis**

310 The final dataset had a two-level structure with triage decisions made during  
311 incoming calls to the service (level-1;  $k = 3,948$ ) nested within individual  
312 nurses (level-2;  $n = 150$ ). Nurses' decision making (1 = conservative; 0 = less  
313 conservative; as defined above) exhibited meaningful and significant  
314 clustering within nurses ( $ICC = 0.079$ ,  $SE = 0.017$ ,  $p < .001$ ) and were  
315 therefore analysed using two-level mixed-effects logistic regression models.  
316 All models included a random intercept, and a fixed effect of shift (first of the  
317 two participation shifts = 0; second shift = 1). Since calls at certain times of  
318 day may be more likely to involve serious conditions (warranting more urgent  
319 responses), all analyses also included time of day (entered as a series of hour  
320 of day dummy variables). As participating nurses worked in either one of the  
321 larger, main call centres ( $n=3$ ) or in a smaller, regional call centre ( $n=4$ ), call  
322 centre size was also controlled for in analyses.

323

324 To test hypothesis 1 (the decision fatigue hypothesis) two models were  
325 estimated with the following fixed effects added: Model (i) number of decisions  
326 i.e. calls since last break; and Model (ii) time elapsed in hours since the last  
327 break. To test hypothesis 2 (the general work hypothesis) a further two  
328 models were estimated, with the following fixed effects added: Model (iii)  
329 number of decisions since the start of the shift; and Model (iv) time elapsed in  
330 hours since the start of the shift. All analyses were carried out in Stata 15.  
331 Statistical significance was set at  $\alpha = .05$ , corrected for multiple comparisons

332 (Bonferroni corrected  $\alpha = .0125$ ).

333

334

## 335 **RESULTS**

336 The participating nurses did not significantly differ from the rest of the NHS 24  
337 workforce in terms of years qualified ( $t_{(373)} = -0.817, p=0.41$ ), years of  
338 employment ( $t_{(271)} = -0.005, p=0.99$ ), or number of hours worked per week ( $t_{(430)} = 1.14, p=0.25$ ).

340 During data collection, participating nurses dealt with 5,325 calls in  
341 total (mean number of calls per nurse = 35.51;  $SD = 11.72$ ). Of these, 95 calls  
342 (1.8%) were coded as 'refused triage' meaning that either the call was  
343 disconnected before a decision was made, or no decision could be agreed  
344 between nurse and patient. As no decision was made during these 'refused  
345 triage' calls, decisions in these cases were recorded as missing and were not  
346 included in the analyses. A further 1,282 calls (24.1%) were outgoing calls  
347 and were also excluded from the analyses as nurses in these cases had  
348 advance knowledge that the call content was non-urgent. The remaining  
349 3,948 calls were standard incoming calls and were included in the analyses.  
350 During these incoming calls, 3,075 (77.9%) of the decisions made were  
351 classified as conservative and 873 (22.1%) as not (see Table 1 for a  
352 breakdown of call outcomes).

353 Participating nurses' shifts were on average 7.09 hours long ( $SD 1.73$ )  
354 and involved an average of 13.78 incoming calls ( $SD= 6.82$ ) each lasting an  
355 average of 15.04 mins ( $SD = 6.08$ ). There were 662 observed breaks lasting  $\geq$   
356 15 mins (mean = 2.30 breaks per shift;  $SD = 1.47$ . Median break length was

357 25 minutes (IQR 19-35). The average time from the end of a break (or from  
358 the start of shift) to the end of the last call taken prior to the next break (or end  
359 of shift) was 2.14 hours (SD=1.12). Nurses took an average of 4.35 incoming  
360 calls (SD=3.61) between breaks.

361

362 [Table 1 here]

363

364 Table 2 presents the fixed effect regression coefficients from all four models  
365 where each model controls for time of day, shift (first or second), and size of  
366 call centre.

367

368 Model i (decisions since break) and ii (time since break) test the **decision**  
369 **fatigue hypothesis**: whether nurses make more conservative decisions the  
370 more consecutive decisions they have made and/or the more time that has  
371 passed *since their last break*. The Model i results show that for every  
372 additional call taken since their last break, the odds of nurses making a  
373 conservative decision increased by 5.5% ( $p = .001$ , 95% CI: 2.2%, 8.8%). The  
374 results for Model ii show a similar effect with time elapsed. The odds of  
375 nurses making a conservative decision increase by 20.5% for every hour that  
376 passes since the last break ( $p < .001$ , 95% CI: 9.1%, 33.2%). This translates  
377 to an increase in odds of 49.0% from the first call after one break to the final  
378 call taken before the next break (i.e. an average of 2.14 hours later).

379

380 Models iii (decisions since start of shift) and iv (time since start of shift), test  
381 the **general work hypothesis**: whether nurses simply become more likely to



382 make more conservative decisions with more effort exerted during the whole  
383 shift. These models found no effect on decision making of number of calls  
384 (decisions) since the start of their shift ( $p = .529$ ) nor time elapsed since start  
385 of shift ( $p = .766$ ).

386

387 [Table 2 here]

388

389

390

## 391 **DISCUSSION**

392

393 The present analysis of ~4,000 clinical decisions made by nurses working for  
394 the telephone based NHS 24 service, revealed evidence of a predictable,  
395 mental-fatigue related bias in clinical decision making. Specifically, nurses  
396 made progressively more conservative and therefore more expensive and  
397 less efficient decisions as the time and the number of decisions made since  
398 their last rest break increased. For every call taken since last break, the odds  
399 of nurses recommending a treatment option that involved callers seeing  
400 another primary or secondary care professional within 12 hours increased by  
401 5.5%: an increase in odds, on average, of 20.5% an hour or 49.0% from just  
402 after one break to just before the next. To convert this into relative  
403 probabilities: relative to the first person to call in after a nurse's break, the  
404 second caller will be 1.3% more likely to be retained within the healthcare  
405 system and seen the same day by another health professional, but the final  
406 caller before the next break will be 8.8% more likely to be seen the same day

407 (i.e. a modelled probability of 75.4% immediately after a break, increasing to  
408 82.0% before the next break). This effect appears to be related specifically to  
409 the number of decisions made / time that has elapsed *since a nurse's last*  
410 *break* and not to an accumulation of general fatigue as decisions were  
411 unaffected by the total number of calls taken or time at work over the shift as  
412 a whole.

413

#### 414 **Theoretical and clinical implications**

415 These results demonstrate that clinical decision makers are not immune to the  
416 cognitive biases demonstrated in a range of other settings including law,  
417 education and marketing (e.g. Danziger et al, 2011; Sievertsen et al, 2016;  
418 Levav et al, 2010). Decision fatigue, i.e. the tendency to become increasingly  
419 likely to go for the 'safe', 'default', or 'easy' option as the number of decisions  
420 made increases, has long been exploited in the commercial sector. Economic  
421 studies, for example, explicitly recommend that high mark-up options be  
422 offered to customers late in a series of decisions to increase the likelihood of  
423 them being accepted (Levav et al, 2010).

424 From a theoretical standpoint, the present findings cannot determine  
425 whether the observed effects arise as the result of depletion of some general  
426 cognitive resource or from a progressive shift in motivation away from current  
427 task, but either way, they demonstrate that the effect is tied to the length of  
428 continuous episodes of work (i.e. without a break) within a work period rather  
429 than to the total or cumulative amount of work over the whole work period.

430 Within the clinical context, decision fatigue serves to bias decision  
431 making in a conservative direction. This is optimal from a patient safety point

432 of view as retaining patients within the healthcare system will maximize the  
433 chances that any detectable health conditions are recognised and treated  
434 quickly. However, an increased tendency to refer patients to primary or  
435 secondary care services within a short time frame may also increase the  
436 number of unnecessary investigations carried out, increase patient anxiety,  
437 skew patient expectations of care, and make less efficient use of limited  
438 resources. Referring large numbers of patients to primary and secondary care  
439 undermines one of the core aims of medical telephone helplines. NHS 24 was  
440 established by the Scottish Government in 2001 with a vision to “.....reduce  
441 the ever increasing burden on existing services” (NHS 24, 2004). Our analysis  
442 suggests that health professionals may become increasingly unable to fulfill  
443 this vision as time since break increases. Furthermore, it implies that at times  
444 when services are under the highest levels of demand, decision making may  
445 be least efficient, since at these times, staff may be less likely to take the  
446 breaks required to combat decision fatigue.

447       Importantly, our analysis suggests that it would not be necessary to  
448 reduce total workload or shift length in order to reduce the effects of decision  
449 fatigue in health professionals. Rather, it suggests that strategic scheduling of  
450 (frequent, short) breaks would be the best way to ensure that decision making  
451 remains efficient throughout shifts. This may be particularly relevant for those  
452 who consciously recognise cognitive changes occurring as previous analyses  
453 from the same dataset (Allan, Farquharson, Johnston, Jones, Choudhary &  
454 Johnston, 2014) indicate that nurses who report noticing that they are making  
455 frequent cognitive failures (slips of attention and memory) are more likely in  
456 general to refer callers on to other services.

457            Much empirical data suggests that breaks from work are restorative, in  
458 that they function to reduce, or even reverse, fatigue-related changes in  
459 decision making and performance. A study of job performance over four  
460 weeks (Binnewies, Sonnetag & Mojza, 2010) found that when people had a  
461 chance to fully recover from work demands during the weekend they reported  
462 better performance of their core work tasks, were more likely to be proactive  
463 and show initiative, and more likely to help others on their return to work.  
464 Similarly, Dai et al (2015) demonstrated that while health professionals'  
465 compliance with hand hygiene guidelines declined systematically over the  
466 course of a 12-hour shift, workers with longer breaks between shifts showed  
467 reduced depletion effects. While these studies look at 'breaks' in terms of  
468 days off work, recent studies suggest that breaks in the day of 20-30 minutes  
469 may be sufficient to completely remove cognitive depletion effects  
470 (Sievertsen et al 2016). Similarly, there is some evidence to suggest that even  
471 breaks of very short durations (3 minutes) are sufficient to mitigate depletion-  
472 related declines in productivity (Dababneh, Swanson & Shell, 2001).

473

#### 474 **Future Directions**

475 Future research may be usefully focused on identifying optimal patterns of  
476 breaks within the working shifts of healthcare professionals. Nursing shifts are  
477 typically longer (8-12 hours) than in other professions (Stimpfel, Sloane &  
478 Aiken, 2012) and it is possible that multiple short breaks spaced across the  
479 working shift (in addition to core meal and rest breaks) would improve rather  
480 than reduce service efficiency. Sievertsen et al (2016) conclude in their study  
481 of cognitive test performance over the day that the beneficial effect that

482 resulted from a 20-30 minute break was larger than the initial depletion effect,  
483 indicating that frequent breaks over the day may actually improve overall  
484 performance. Future studies could investigate varying lengths of break,  
485 possibly using an experimental design. Clearly, in a demanding and often  
486 short staffed NHS setting, the logistical reality of providing staff with frequent  
487 breaks is extremely challenging, but the present analysis suggests this is  
488 worth exploring. It is estimated that primary care appointments cost the NHS  
489 an average of £120 each (NHS Information Services Division, 2012) so it is  
490 possible that frequent, short breaks, if they can safely reduce the number of  
491 patients being referred onto other services, could be cost effective.

492           For further development of theory, it is important to investigate whether  
493 decision fatigue effects are indeed the result of progressive shifts in  
494 motivation away from the current task. If so, then strategic incentives or  
495 scheduled changes between different tasks may mitigate the effects.

496           Finally, the present study focused on telephone based nurses who are  
497 largely sedentary during working hours. Future studies should investigate  
498 whether decision fatigue is enhanced or ameliorated in physically active,  
499 ward-based nurses, that is, whether physical and mental fatigue effects  
500 interact.

501

## 502 **Strengths and weaknesses**

503 The present study utilises existing data on the timing and outcome of ~4,000  
504 real clinical decisions and the analytical approach allows important theoretical  
505 predictions about changes in this clinical decision making to be tested within  
506 people over time. As the data replicate the decision fatigue phenomenon

507 observed in other professional groups (judges, GPs), it is likely that the results  
508 are generalizable to other occupational settings. In terms of limitations, the  
509 present study is observational in nature: it was not possible to experimentally  
510 manipulate the timing and frequency of breaks. In addition, as data on call  
511 content was not available, it was not possible to determine whether the  
512 observed shift towards more conservative decisions was clinically less  
513 'appropriate'. While similar studies indicate that clinicians' decision making  
514 does become less appropriate over time (Linder et al, 2014), this could not be  
515 tested directly in the present study. Finally, breaks were identified as any  
516 period of >15 minutes between calls. While all such periods reflect a break  
517 from active work, this method of classification is likely to include both officially  
518 designated breaks where nurses are completely 'off-task' and periods of  
519 inactivity at the workstation while still 'available for call'. The opportunities to  
520 rest and recuperate from work may be reduced in the latter case and  
521 consequently, the reported results may underestimate the magnitude of any  
522 effect of breaks on decision making.

523

524 In conclusion, every consecutive decision that occurs, or hour that passes  
525 since a break, produces a predictable and measurable change in nurses'  
526 decision making that may function to gradually reduce service efficiency over  
527 the working day. Future research should focus on identifying an optimal  
528 pattern of breaks to minimize these effects.

529

530

531 **REFERENCES**

532 Allan, J.L., Farquharson, B., Choudhary, C.J., Johnston, D.W., Jones, M.C. &  
533 Johnston, M. (2009). Stress in telephone helpline nurses: research protocol  
534 for a study of theoretical determinants, physiological aspects and behavioural  
535 consequences. *Journal of Advanced Nursing*, 65, 2208-2215.

536

537 Allan, J.L., Farquharson, B., Johnston, D.W., Jones, M.C., Choudhary, C.J. &  
538 Johnston, M. (2014). Stress in telephone helpline nurses is associated with  
539 failures of concentration, attention and memory, and with more conservative  
540 referral decisions. *British Journal of Health Psychology*, 105, 200-213.

541

542 Arai, T. (1912). *Mental Fatigue*. New York City: Columbia University.

543

544 Baumeister, R.F. (2002). Ego depletion and self-control failure: an energy  
545 model of the self's executive function. *Self Identity*, 1, 129-136.

546

547 Baumeister, R.F., Bratslavsky, E., Muraven, M., & Tice, D.M. (1998). Ego  
548 depletion: Is the active self a limited resource? *Journal of Personality and*  
549 *Social Psychology*, 74, 1252–1265.

550

551 Binnewies, C., Sonnetag, S., & Mojza, E.J. (2010). Recovery during the  
552 weekend and fluctuations in weekly job performance: A week-level study  
553 examining intra-individual relationships. *Journal of Occupational and*  
554 *Organizational Psychology*, 83, 419-441.

555

556 Chan, M.Y., Cohen, H., & Spiegel, M.R. (2009). Fewer polyps detected by  
557 colonoscopy as the day progresses at a veteran's administration teaching  
558 hospital. *Clinical Gastroenterology and Hepatology*, 7, 114-1142.  
559

560 Chudleigh, J., Fletcher, M., & Gould, D. (2005). Infection control in neonatal  
561 intensive care units. *Journal of Hospital Infection*, 61, 123-129.  
562

563 Dababneh, A.J., Swanson, N., & Shell, R.L. (2001). Impact of added rest  
564 breaks on the productivity and wellbeing of workers. *Ergonomics*, 44, 164-  
565 174.  
566

567 Dai, H., Milkman, K.L., Hofmann, D.A., & Staats, B.R. (2015). The impact of  
568 time at work and time off from work on rule compliance: the case of hand  
569 hygiene in health care. *Journal of Applied Psychology*, 100, 846-862.  
570

571 Danziger, S., Levav, J., & Avnaim-Pesso, L. (2011). Extraneous factors in  
572 judicial decisions. *Proceedings of the National Academy of Sciences*, 108,  
573 6889-6892.  
574

575 Glockner, A. (2016). The irrational hungry judge effect revisited: Simulations  
576 reveal that the magnitude of the effect is overestimated. *Judgment & Decision*  
577 *Making*, 11, 601-610.  
578



579 Hagger, M.S., Chatzisarantis, N.L.D., Alberts, H., Anggono, C.O., Batailler, C.  
580 et al. (2016). A multilab preregistered replication of the ego-depletion effect.  
581 *Perspectives on Psychological Science*, 11, 546-573.  
582

583 Inzlicht, M., & Schmeichel, B.J. (2012). What is ego depletion? Toward a  
584 mechanistic revision of the resource model of self control. *Perspectives on*  
585 *Psychological Science*, 7, 450-463.  
586

587 Inzlicht, M., Schmeichel, B.J., & Macrae, C.N. (2014). Why self control seems  
588 (but may not be) limited. *Trends in Cognitive Science*, 18, 127-133.  
589

590 Johnston, D.W., Allan, J.L., Powell, D.J.H., Jones, M.C., Farquharson, B.,  
591 Bell, C., & Johnston, M. (2018). Why does work cause fatigue? A real-time  
592 investigation of fatigue, and determinants of fatigue in nurses working 12-hour  
593 shifts. *Annals of Behavioral Medicine*, Aug 16. doi: 10.1093/abm/kay065.  
594 [Epub ahead of print].  
595

596 Kahneman, D. (2012). *Thinking fast and slow*. London: Penguin Books.  
597

598 Kouchaki, M., Smith, I.H. (2014). The morning morality effect: the influence of  
599 time of day on unethical behavior. *Psychological Science*, 25, 95-102.  
600

601 Kurzban, R., Duckworth, A., Kable, J.W., & Myers, J. (2013). An opportunity  
602 cost model of subjective effort and task performance. *Behavioral and Brain*  
603 *Sciences*, 36, 10.1017/S0140525X12003196.

604

605 Levav J, Heitmann M, Herrmann A, & Iyengar SS. Order in product  
606 customization decisions: evidence from field experiments. *J Polit Econ*  
607 2010;118:274-299.

608

609 Linder, J.A., Doctor, J.N., Friedberg, M.W., Reyes Nieva, H., Birks, C.,  
610 Meeker, D., & Fox, C.R. (2014). Time of day and the decision to prescribe  
611 antibiotics. *JAMA Internal Medicine*, 174, 2029–2031.

612

613 McKee, H.C., Ntoumanis, N., & Taylor, I.M. (2014). An ecological momentary  
614 assessment of lapse occurrences in dieters. *Annals of Behavioral Medicine*,  
615 48, 300-310.

616

617 NHS 24 Board Meeting Minutes, July 2004. Accessed from  
618 [http://www.nhs24.com/aboutus/nhs24board/agendasandpapers/2004/july/~m](http://www.nhs24.com/aboutus/nhs24board/agendasandpapers/2004/july/~media/nhs24/agendas%20and%20papers/2004/july/20040728%20item%2041%20blueprint%20execution.ashx)  
619 [edia/nhs24/agendas%20and%20papers/2004/july/20040728%20item%2041](http://www.nhs24.com/aboutus/nhs24board/agendasandpapers/2004/july/20040728%20item%2041%20blueprint%20execution.ashx)  
620 [%20blueprint%20execution.ashx](http://www.nhs24.com/aboutus/nhs24board/agendasandpapers/2004/july/20040728%20item%2041%20blueprint%20execution.ashx)

621

622 NHS Scotland Information Services Division. (2012). Cost Book. NHS  
623 Scotland.

624

625 Pignatiello, G.A., Martin, R.J., & Hickman Jr, R.L. (2018). Decision fatigue: A  
626 conceptual analysis. *Journal of Health Psychology*, doi:  
627 10.1177/1359105318763510. [Epub ahead of print].

628

629 Sievertsen, H.H., Gino, F., & Piovesan, M. (2016). Cognitive fatigue  
630 influences students' performance on standardized tests. *Proceedings of the*  
631 *National Academy of Sciences*, 113, 2621-2624.  
632

633 Stimpfel, A.W., Sloane, D.M., & Aiken, L.H. The longer the shifts for hospital  
634 nurses, the higher the levels of burnout and patient dissatisfaction. *Health*  
635 *Affairs*, 31, 2501–2509.

636

637 Weinshall-Margel, K., & Shapard, J. (2011). Overlooked factors in the analysis  
638 of parole decisions. *Proceedings of the National Academy of Sciences*, 108,  
639 E833.

640 *Table 1. Descriptive data on calls*  
 641  
 642

<b>Decision taken by nurse</b>	<b>Frequency (n)</b>
Referral within 12 hours (conservative) - Total	3075
<i>Ambulance sent</i>	390
<i>Urgently attend accident &amp; emergency</i>	277
<i>Urgently attend GP surgery</i>	2382
<i>Urgently speak to GP</i>	17
<i>Other<sup>a</sup></i>	9
Referral outside 12 hour window (less conservative)- Total	873
<i>Attend GP surgery</i>	320
<i>Speak to GP</i>	3
<i>Information provided</i>	176
<i>Self-care advised</i>	237
<i>Other<sup>b</sup></i>	137
Refused Triage	95
Total calls handled	4043

643 <sup>a</sup> Other conservative referrals included to pharmacist, dentist, midwife, primary care  
 644 emergency centre

645 <sup>b</sup> Other less conservative referrals included to pharmacist, dentist, midwife, health visitor,  
 646 public health nurse, police, optician, breathing space (mental health) or poison information  
 647 service.

648  
 649

650  
 651  
 652  
 653  
 654  
 655  
 656  
 657

*Table 2. Mixed effects logistic regressions predicting likelihood of nurses making conservative decisions from (i) number of decisions (calls) since last break, (ii) hours since last break, (iii) number of decisions (calls) since start of shift and (iv) hours since start of shift. Time was entered as a series of dummy hour of day variables and is included in all analyses shown. Complete tables (showing time variables in full) can be found in Supplementary Table S1.*

	Odds Ratio	S.E	<i>p</i>	95% CI	
				Lower	Upper
<b>Model i</b>					
<b>Decisions Since Break</b>					
Intercept	3.135	0.649	< .001	2.089	4.703
Shift <sup>a</sup>	0.938	0.076	.430	0.801	1.090
Center Type <sup>b</sup>	1.891	0.353	.001	1.311	2.728
Decisions (calls) since break <sup>c</sup>	1.055	0.017	.001	1.022	1.088
McKelvey & Zavoina Pseudo R <sup>2</sup>	0.065				
<b>Model ii</b>					
<b>Time Since Break</b>					
Intercept	3.067	0.635	< .001	2.044	4.603
Shift <sup>a</sup>	0.938	0.0766	.425	0.800	1.098
Center Type	1.825	0.344	<.001	1.289	2.668
Time (hrs) since break <sup>c</sup>	1.205	0.061	<.001	1.091	1.332
McKelvey & Zavoina Pseudo R <sup>2</sup>	0.066				
<b>Model iii</b>					
<b>Decisions Since Starting</b>					
Intercept	3.410	0.739	< .001	2.230	5.215
Shift <sup>a</sup>	0.933	0.753	.390	0.796	1.093
Center Type	1.836	0.344	.001	1.272	2.651

Decisions (calls) since start of shift	1.006	0.009	.529	0.988	1.023
McKelvey & Zavoina Pseudo R <sup>2</sup>	0.060				

---

**Model iv**

**Time Since Starting**

---

Intercept	3.685	0.841	< .001	2.356	5.765
Shift <sup>a</sup>	0.936	0.076	.412	0.799	1.097
Center Type	1.830	0.343	<.001	1.267	2.643
Time (hrs) since start of shift	0.992	0.026	.766	0.942	1.045
McKelvey & Zavoina Pseudo R <sup>2</sup>	0.060				

---

658  
659  
660  
661

<sup>a</sup> Shift coded as 0 = shift one, 1 = shift two; <sup>b</sup> center type coded as 0 = three large centers, 1 = four small centers; <sup>c</sup> Since last break, or start of shift if in first call period.