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BRIEF REPORT

Cognitive Overload? An Exploration of the Potential Impact of Cognitive Functioning in Discrete Choice Experiments with Older People in Health Care

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ABSTRACT

Objectives: This exploratory study sought to investigate the effect of cognitive functioning on the consistency of individual responses to a discrete choice experiment (DCE) study conducted exclusively with older people. **Methods:** A DCE to investigate preferences for multidisciplinary rehabilitation was administered to a consenting sample of older patients (aged 65 years and older) after surgery to repair a fractured hip (N = 84). Conditional logit, mixed logit, heteroscedastic conditional logit, and generalized multinomial logit regression models were used to analyze the DCE data and to explore the relationship between the level of cognitive functioning (specifically the absence or presence of mild cognitive impairment as assessed by the Mini-Mental State Examination) and preference and scale heterogeneity. **Results:** Both the heteroscedastic conditional logit and generalized multinomial logit models indicated that the presence of mild cognitive impairment did not have a significant effect on the consistency of responses to the DCE. **Conclusions:** This study provides important preliminary evidence relating to the effect of mild cognitive impairment on DCE responses for older people. It is important that further research be conducted in larger samples and more diverse populations to further substantiate the findings from this exploratory study and to assess the practicality and validity of the DCE approach with populations of older people.

Keywords: cognition, discrete choice experiments, older people.

Introduction

There has been an exponential increase in the number of discrete choice experiment (DCE) studies undertaken within health care during the last two decades since the first seminal article by Propper [1] to assess the disutility of time spent on National Health Service waiting lists. Despite the increase in their proliferation, however, DCE studies specifically designed for and conducted with older people remain relatively rare in comparison with those conducted and reported on with general adult samples. Given future patterns of sociodemographic change and the aging of the population, it is reasonable to expect that the development of DCE studies designed specifically for application with older people is likely to increase markedly during the coming decades. The reliability of DCE responses from older people with varying levels of cognition and the threshold level of cognitive ability required for an older person to reliably complete a DCE are therefore highly important but currently under-researched areas of investigation. This exploratory study sought to investigate this issue empirically by assessing the potential effect of cognitive functioning on DCE-generated responses from a sample of older people recovering from hip fracture. Specifically, we used mixed logit, heteroskedastic conditional logit, and generalized multinomial logit regression models to more formally investigate the potential for preference and scale heterogeneity in responses for the total sample and by subgroups classified according to the absence or existence of mild cognitive impairment.

Methods

Questionnaire Design and Administration

A DCE questionnaire was developed for administration with a population of older people recovering from surgery to repair a fractured hip. The design and administration of the DCE questionnaire are discussed in detail in a separate article [2]. The DCE comprised four salient attributes relating to rehabilitation

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therapy after hip fracture including levels of pain and effort endured, the risk of further falls and injury from participating in rehabilitation therapy, and the level of mobility achieved. Following approval by the relevant research ethics committee, participants for the DCE were recruited from two hospitals in Adelaide, South Australia, sequentially over an 18-month period between May 2009 and November 2010. Patients were approached for participation if they had been admitted to a hospital with a falls-related proximal femur fracture, were 60 years or older, and were not currently receiving palliative care.

Cognitive functioning was assessed by using the Mini-Mental State Examination (MMSE), a routinely administered brief instrument for the measurement of global cognitive function [3]. The MMSE was developed in 1975 and has since proven to be valid and reliable across various clinical, epidemiological, and community survey studies [4]. MMSE scores were categorized according to the three group categorization criteria adopted by Tombaugh and McIntyre's [4] seminal review, whereby a score of 17 or below indicates severe cognitive impairment, a score of 18 to 23 indicates mild cognitive impairment, and a score of 24 or above indicates no cognitive impairment. For patients classified with severe cognitive impairment, informed consent was sought from a proxy family member who was also asked to complete the DCE questionnaire on behalf of the patient and from the patient's perspective.

The DCE questionnaire was administered using an interviewer mode of administration, postoperatively at approximately 1 to 2 weeks after surgery to repair the fractured hip. In advance of the main study, the DCE questionnaire was piloted with a small sample of patients (N = 10) with a range of levels of cognitive function to check respondents' understanding of the questions and to indicate that they were providing meaningful responses. The findings from the pilot study indicated that patients with mild cognitive impairment (MMSE score 19–23) were able to fully complete the questionnaire and were also able to provide meaningful responses. Minor changes to question layout and phraseology were made as a consequence of the findings of the pilot study to improve participant understanding.

Data Analysis

The data from the DCE were analyzed within the framework of random utility theory, which assumes that respondents choose the alternative that maximizes their utility. Let U_{itj} be the utility individual i derives from choosing alternative j in choice scenario t. Utility is given by

$$U_{itj} = x'_{itj}\beta_i + \varepsilon_{itj}$$

where x_{itj} is a vector of observed attributes of alternative j, β_i is a vector of individual-specific coefficients reflecting the desirability of the attributes, and ε_{itj} is a stochastic term. For a traditional linear-index model (i.e.,$x'_{itj}\beta_i$), the probability of respondent i choosing alternative j in choice situation t can be specified as follows:

$$\Pr(\text{choice}_{it} = j \Big| \beta_i = \frac{\exp(\sigma_i x'_{itj}\beta_i)}{\sum_{k=1}^{j} \exp(\sigma_i x'_{itk}\beta_i)}$$

where σ_i is an individual-specific scale of the idiosyncratic error, which is inversely proportional to the error variance. Effects coding was used for the analysis of the DCE data. Four key econometric model specifications were applied ranging in their respective levels of model sophistication: 1) the simple conditional logit (which is unable to take account of either preference or scale heterogenity); 2) the heteroskedastic conditional logit (which can take account of scale heterogeneity); 3) the mixed logit (accounting for taste or preference heterogeneity); and 4) the advanced generalized multinomial logit (G-MNL, which takes account of both preference and scale heterogeneity simultaneously) [5–9].

Within this data set, it is reasonable to hypothesize that participants in the lower cognitive functioning subgroup may make choices that are considerably less consistent (or with a larger error variance) than those in the higher cognitive functioning subgroup. A heteroscedastic conditional logit model was used to test whether error variances differed according to lower or higher cognitive functioning [6–8]. To account for taste or preference heterogeneity, a mixed logit model was used, by specifying β_i to follow a distribution of which the mean and SD are estimated [9]. Finally, the recently operationalized G-MNL model, which can accommodate both preference and scale heterogeneity in a single model, was used [10]. Information criteria are commonly used to choose the overall fit of DCE models, with the Bayesian information criterion being increasingly used as the preferred measure [11]. All econometric analyses were conducted in Stata version 12.1 (StataCorp LP, College Station, TX), using clogit, clogithet [12], mixlogit [13], and gmnl [14] commands.

Comparisons between choice models that have been generated from two groups of respondents need to take account of differences in unobserved variability (i.e., scale) between the data sources [15]. For example, a comparison between a sample of patients with higher levels of cognitive functioning and a sample of patients with lower levels of cognitive functioning, as seen in this study, would need to take account of scale differences. The Swait and Louviere test was used to formally test for such differences across the two subsamples [16].

Results

A total of 149 patients who had recently undergone surgery to repair a hip fracture were approached, of whom 87 (58%) consented to participate in the study and 84 (56%) fully completed all the DCE questions (74 patients and 10 proxy family members). Table 1 presents a summary of characteristics of the participants. For the self-completing participants, the majority (n = 52, 70%) were women and the mean age was 80 years. While a small proportion (n = 10, 14%) were living in residential care before fracture, the vast majority were living independently in the community before admission (n = 64, 86%). The majority of self-completing participants (68%) were classified with normal cognitive function and were born in Australia (73%). In addition, the vast majority (84%) indicated that they found the DCE task either "not" or "slightly" difficult to complete and all 84 participants (100%) passed the test of internal consistency.

The results from the conditional logit regression model based on the total sample (including proxy respondents), on the self-reporting sample (excluding proxy respondents), and on self-reporting subsamples partitioned according to cognitive functioning (higher cognitive functioning and lower cognitive functioning) are presented in Table 2. Column 1, comprising the total sample, indicates that participants exhibited statistically significant positive preferences for the lowest risk of future falls (25%) and for improvements in mobility (walking with a frame with one person close-by and walking with a stick independently without help) and statistically significant negative preferences for the highest level of pain during rehabilitation (severe pain) and the longest duration of rehabilitation intervention (2 hours per day for 2 months). It can be seen from column 2 that results for the self-reporting sample (excluding proxy respondents) are very similar to results for the total sample. Columns 3 and 4 in Table 2 present results from the self-reporting subsamples partitioned according to cognitive functioning. For respondents without cognitive impairment (i.e., MMSE score ≥ 24), the conditional logit estimates

Table 1 – Participant characteristics.

Characteristic	Self-reported (N = 74), n (%)[†]	Proxy[*] (N = 10), n (%)[†]
Age (y), mean ± SD	80 ± 8.5	82 ± 6.9
Sex: female	52 (70)	7 (70)
MMSE score[‡]		
Normal (24–30)	48 (68)	–
Mild (18–23)	23 (32)	–
Education[‡]		
No qualifications	32 (44)	5 (50)
High school	35 (48)	5 (50)
Degrees/ professional qualification	6 (8)	0
Live in community	64 (86)	4 (40)
Live in residential care	10 (14)	6 (60)
Born in Australia	53 (73)	8 (80)
Difficulty[‡]		
Not	39 (56)	4 (40)
Slightly	20 (28)	4 (40)
Very or moderately	11 (16)	2 (20)

MMSE, Mini-Mental State Examination.

* Characteristics reflect patients in the proxy group with the exception of the MMSE score, which was not available for proxy respondents.

† Unless otherwise indicated.

‡ MMSE score missing = 3, Education missing = 1, Born in Australia missing = 1, Difficulty missing = 4.

are broadly consistent with the total sample. For individuals with minor cognitive impairment (i.e., MMSE score ranging between 19 and 23), however, the pain attribute became insignificant. These results are supported by application of the Swait and Louviere test, which confirmed that by splitting the sample on the basis of cognitive functioning, the null hypothesis of equal preferences could not be rejected at the 10% level.

The results from the heteroscedastic conditional logit model to investigate whether self-reporting respondents' characteristics had an effect on the error variance are presented in column 5 of Table 2. The MMSE score was included as a dummy variable reflecting higher or lower cognitive functioning. The coefficient relating to cognitive functioning was positive, indicating that respondents with a higher level of cognitive functioning tended to exhibit higher scale and thus lower error variance; however, this was not found to be statistically significant.

Preference heterogeneity was investigated through the application of a mixed logit regression model by specifying the coefficients attached to each attribute level (β_i) to follow a normal distribution with associated mean and SD. Based on the BIC values, the results suggest that, first, only the attribute levels relating to mobility were found to be statistically significant, and, second, random coefficients assumed to be independent are preferable. The above findings were then incorporated into the G-MNL model. Column 6 in Table 2 reports results from application of the G-MNL model, which accounts for both scale and preference heterogeneity simultaneously. The parameter γ (which governs how the variance of residual preference heterogeneity varies with scale) was estimated both without any boundary restriction and also on two special cases (i.e., $\gamma = 0$ and $\gamma = 1$). For the sake of simplicity, only the preferred G-MNL estimates (selected on the basis of BIC values) are reported. In comparison with heteroscedastic conditional logit model results, the G-MNL model also indicates that the dummy variable attached to cognitive functioning is statistically insignificant (column 6, Table 2). All other conclusions remain the same across both heteroscedastic conditional logit and G-MNL models, principally that the MMSE score is statistically insignificant and only the mobility attribute exhibits robust statistically significant SDs.

Discussion

This article investigated the potential role of cognitive functioning in DCE using a sample of older patients after surgery to repair a fractured hip. Preference heterogeneity was found to be significant only for the mobility attribute, and no evidence of a relationship between scale heterogeneity and the level of cognitive functioning was found. A limitation of our study was that information relating to MMSE scores for proxy respondents was unavailable and hence they were excluded from subsample analyses. Proxy respondents, however, made up a small proportion of the total sample. There is evidence from the stated preference literature to indicate that proxy responses may not be equivalent to responses of people with cognitive impairment [17,18]. The reliability of proxy responses for DCEs has not been investigated thoroughly to date and is an important area for future research.

There are several possible explanations for our findings. Although MMSE is presently the most widely applied instrument internationally for assessing cognitive impairment, it may not be the most appropriate test of cognitive functioning for application with DCE studies. In a comprehensive review of screening tests for cognitive impairment, Cullen et al. [19] noted that although a total of 39 screening tests designed for this purpose were identified, clinician surveys indicate that the MMSE is "overwhelmingly ubiquitous in practice." The MMSE was found to lack coverage in both verbal fluency and reasoning/judgment domains. The ability to apply logical reasoning and judgment, however, is clearly an important requirement for a participant to provide meaningful responses to a DCE. Therefore, although the MMSE appears reasonable at categorizing individuals with higher and lower cognitive functioning, it may not provide a good measure of a person's ability to carry out logical reasoning [20]. This may provide at least a partial explanation as to why we failed to observe a consistent relationship between cognitive impairment and scale heterogeneity. Future research is needed to further assess the discriminative abilities of the MMSE in relation to other more comprehensive screening tests in categorizing individuals with higher and lower cognitive functioning for purposes of participation and data analysis for DCE studies.

In practice, the effect of the task environment, the complexity of the DCE task, and the cognitive capacity of the participant are likely to be highly interdependent. Within this study, we deliberately sought to simplify the DCE design and minimize the complexity of the DCE task in two main ways. First, by focusing on four salient attributes with three levels attached to each attribute, and, second, by blocking the design into three versions to reduce the number of choice sets required for presentation [2]. The simplification of the task may therefore have contributed to the main finding of the insignificance of the level of cognitive functioning on scale heterogeneity and it is possible that scale heterogeneity may be more evident when more complex DCE tasks are conducted. Previous studies conducted exclusively in populations of older people have tested the effect of the complexity of the DCE task in terms of the mode of administration and the number of choice sets presented [21–23]. These studies found that participant understanding and completion rates were significantly elevated using an interviewer mode of administration with visual props (in the form of choice sets handed one at a time to the participant for consideration) as opposed to a traditional

Table 2 – Regression results.

Attributes	Description	Attribute levels[*]	Conditional logit				HCL[†]	G-MNL[‡]
			(1)	(2)	(3)	(4)	(5)	(6)
			Full sample	Self-reported sample	MMSE score ≥24	MMSE score 19–23		
Risk	Your risk of falling and breaking another bone at some time point after rehabilitation	50%	0.088 (0.110)	0.121 (0.103)	0.009 (0.136)	0.282 (0.185)	0.078 (0.096)	0.045 (0.254)
		25%	0.357[§] (0.118)	0.373[§] (0.110)	0.404[§] (0.152)	0.518[§] (0.200)	0.369[§] (0.112)	1.331[§] (0.456)
Pain	The level of pain you would need to accept during rehabilitation with the aim of recovering your ability to walk short distances	Moderate pain for 6–8 wk	0.222[§] (0.084)	0.214[‖] (0.112)	0.327[¶] (0.152)	0.120 (0.194)	0.208[¶] (0.103)	0.585[¶] (0.264)
		Severe pain for 6–8 wk	−0.369[§] (0.100)	−0.332[§] (0.108)	−0.378[¶] (0.150)	−0.209 (0.185)	−0.270[§] (0.103)	−0.693[§] (0.247)
Effort	The level of effort you would need to make during rehabilitation by working hard and exercising with a physiotherapist	1 h/d for 2 mo	−0.013 (0.098)	0.021 (0.100)	−0.114 (0.133)	0.193 (0.180)	−0.019 (0.091)	−0.064 (0.205)
		2 h/d for 2 mo	−0.355[§] (0.104)	−0.417[§] (0.114)	−0.297[¶] (0.151)	−0.650[§] (0.214)	−0.349[§] (0.120)	−1.115[§] (0.372)
Mobility	Your ability to recover walking after rehabilitation	Walking with a frame with one person close-by	0.312[§] (0.107)	0.266[§] (0.098)	0.341[§] (0.129)	0.122 (0.176)	0.241[§] (0.091)	0.752[¶] (0.304)
		Walking with a stick independently without help	1.066[§] (0.149)	1.118[§] (0.116)	1.282[§] (0.158)	1.094[§] (0.220)	1.023[§] (1.169)	3.594[§] (1.014)
SD								
Frame								1.330[§] (0.432)
Stick								3.163[§] (0.820)
HET								
MMSE score: 24–30 (dummy)							0.206 (0.192)	0.021 (0.219)
τ								0.032 (0.139)
LL			−219.816	−191.096	−112.877	−60.792	−177.783	−144.593
AIC			455.631	398.191	241.753	137.585	373.565	313.185
BIC			461.756	432.114	272.194	162.186	411.352	363.567
N			84	74	48	23	71	71
Observations			583	513	332	160	492	492

Notes: Except for column 1, all others used only the self-reported sample. Effects coding was used. Standard errors in parentheses. HET, variables used to model error variance.
AIC, Akaike information criterion; BIC, Bayesian information criterion; G-MNL, generalized multinomial logit; HCL, heteroscedastic conditional logit; LL, log likelihood; LM, Lagrange multiplier test; MMSE, Mini-Mental State Examination.

[*] The omitting levels are as follows: 75% (risk attribute), mild pain for 6 to 8 wk (pain attribute), 30 min/d for 2 mo (effort attribute), and wheelchair bound (mobility attribute).

[†] The null hypothesis for the LM test that the error variance is constant across respondents cannot be rejected (LM test statistics = 1.16).

[‡] Random coefficients are assumed to be independent, γ is set to be 1, 500 Halton draws.

[§] $P < 0.01$.

[‖] $P < 0.1$.

[¶] $P < 0.05$.

self-completion format with all choice sets presented simultaneously in a single questionnaire. In addition, participant fatigue precluded the presentation of more than six or seven binary choice sets within a single interview.

This exploratory study involved face-to-face interviews, which are more expensive than other forms of data collection, and hence the sample size was relatively small when compared with samples achieved from other sources (e.g., online panels). Our sample size, however, is larger than that in many DCE studies reported in the literature that have also incorporated more advanced modeling approaches [22,24–26]. Further research is needed in larger samples and more diverse populations to substantiate these preliminary findings and to investigate the reliability and validity of the DCE approach in populations of older people, including those with mild cognitive impairment.

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