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Self-regulation is often promoted as a coping strategy that may allow older drivers to drive safely for longer. Self-regulation depends upon drivers making an accurate assessment of their own ability and having a willingness to practice self-regulatory behaviors to compensate for changes in ability. The current study explored the relationship between older drivers' cognitive ability, their driving confidence and their use of self-regulation. An additional study aim was to explore the relationship between these factors and older drivers' interest in driving programs. Seventy Australian drivers aged 65 years and over completed a questionnaire about their driving and a brief screening measure of cognitive ability (an untimed Clock Drawing Test). While all participants reported high levels of confidence regarding their driving ability, and agreed that they would continue driving in the foreseeable future, a notable proportion performed poorly on the Clock Drawing Test. Compared to older drivers who successfully completed the Clock Drawing Test, those who failed the cognitive test were significantly less likely to report driving self-regulation, and showed significantly less interest in being involved in driving programs. Older drivers with

Running Head: Self-regulation and cognitive ability of older drivers

**The relationship between cognitive ability, insight and self-regulatory behaviors:
Findings from the older driver population**

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Abstract

Self-regulation is often promoted as a coping strategy that may allow older drivers to drive safely for longer. Self-regulation depends upon drivers making an accurate assessment of their own ability and having a willingness to practice self-regulatory behaviors to compensate for changes in ability. The current study explored the relationship between older drivers' cognitive ability, their driving confidence and their use of self-regulation. An additional study aim was to explore the relationship between these factors and older drivers' interest in driving programs. Seventy Australian drivers aged 65 years and over completed a questionnaire about their driving and a brief screening measure of cognitive ability (an untimed Clock Drawing Test). While all participants reported high levels of confidence regarding their driving ability, and agreed that they would continue driving in the foreseeable future, a notable proportion performed poorly on the Clock Drawing Test. Compared to older drivers who successfully completed the Clock Drawing Test, those who failed the cognitive test were significantly less likely to report driving self-regulation, and showed significantly less interest in being involved in driving programs. Older drivers with declining cognitive abilities may not be self-regulating their driving. This group also appears to be unlikely to self-refer to driving programs.

Keywords: Driving; Older adults; Driving self-regulation; Insight; Cognitive Ability

1. Introduction

Previous literature has identified that older drivers generally have a higher crash risk than do other age groups after adjusting for driving exposure (Cerelli, 1995; Holland, 2002). As older drivers generally drive less distance per year than do drivers in other age groups, debate exists whether the increased crash risk among older drivers is an artefact of the low mileage bias (i.e. the lower the annual mileage driven, the higher the per-distance crash rate; Langford, Methorst & Hakamies-Blomqvist, 2006). Nevertheless, the increased fragility of older drivers places them at a disproportionate risk of sustaining serious injury or death as a result of being involved in a crash (McGwin et al., 2000; Meuleners et al., 2006). Aside from the potentially significant negative consequences that older drivers face if they are involved in a motor vehicle accident, there are also substantial economic and social costs to the community of such accidents (Miller et al., 2008). Given the projected increase in the number of older drivers in the near future (e.g. Organisation for Economic Cooperation and Development, 2001) and their heightened risk of serious crash-related injury, maintaining the safety of older drivers has been identified as a key priority for many injury prevention agencies.

Emerging older driver studies have highlighted the potential use of self-regulation to assist older people to maintain functional mobility and independence. Self-regulation typically refers to the notion that older drivers may adjust, or reduce, their driving in response to changes in their health and functional abilities (Donorfio, D'Ambrosio, Coughlin & Mohyde, 2009). Specifically, as driving in certain conditions becomes more difficult because of increasing resource limitations (e.g., reduced visual acuity or cognitive ability), older drivers may restrict their driving to those times and conditions in which they feel safe (Ball et al., 1998; Hakamies-

Blomqvist & Wahlstrom, 1998; Stalvey & Owsley, 2000). A recent qualitative study by Donorfio, D'Ambrosio, Coughlin and Mohyde (2009) also revealed that, when asked to define self-regulation, older drivers emphasised psychological factors surrounding independence, self-worth and confidence.

As noted previously, self-regulation is formally promoted as a strategy that allows older drivers to continue to drive safely for longer. It has also been suggested as a means of avoiding a range of negative outcomes that have been associated with driving cessation such as social isolation and increased depressive symptoms (Fonda et al., 2001; Marottoli et al., 1997). However, the extent to which older people regulate their driving, and indeed, exactly how they do so, remains unclear (Ball et al., 1998, Baldock et al., 2006, Charlton et al., 2006; Molnar & Eby, 2008). Further, older drivers are still overrepresented in terms of accident risk, even after adjusting for driving exposure (Cassavaugh & Kramer, 2009; Langford & Koppel, 2008), which suggests that this strategy is ineffective at the population level.

A growing body of literature indicates that driving confidence is a key factor in determining why some older drivers regulate their driving but others do not (Baldock et al., 2006; Myers et al., 2008, Molnar & Eby, 2008; MacDonald et al., 2008; Rudman et al., 2006). Specifically, driving confidence has been reported to be significantly related to subjectively-assessed driving self-regulation (e.g. Baldock et al., 2006; MacDonald et al., 2008; Molnar & Eby, 2008). In addition, Blanchard and Myers (2010) observed significant correlations between older drivers' driving confidence and actual changes in their driving patterns (i.e., reduced driving exposure and reduced driving range radii from home).

Emerging studies suggest that awareness of functional abilities may be another critical factor in determining self-regulation among older drivers (Blanchard & Myers, 2010; Charlton et al., 2006; Molnar & Eby, 2008). In support of this notion, Holland and Rabbitt (1992) demonstrated that older drivers who noticed deterioration in their abilities were more likely to practice self-regulation, than were those who were less self-aware. Similarly, MacDonald and colleagues (2008) found situational driving frequency and avoidance to be more strongly related to drivers' perceived comfort and abilities than to their objective driving performance. Hence, drivers' insight into their impairments (in other words their cognitive ability) may be a key determinant of subsequent self-regulatory behaviors. To date, no studies have examined the relationship between drivers' cognitive ability, perceived driving ability, driving confidence and self-regulatory behaviors.

This study was designed to explore the relationship between cognitive ability and the use of driving self-regulation in a group of older drivers. Many current older driver programs (e.g., on-road driver training or in-class educational programs) rely on self-selection, and if driving self-awareness is poor, or is impacted by cognitive impairments, the most in need of such programs may not recognise this need. Thus, an additional aim of the current study was to investigate the potential relationship between participants' performance on a screening test of cognitive ability and their perceived need for, and willingness to attend, older driver programs. It was anticipated that participants' levels of cognitive ability would influence their driving confidence, and their subsequent use of self-regulatory behaviors, as well as their interest in older driver programs.

2. Method

2.1. Participants

Participants were a convenience sample of 72 drivers (65.3% female) aged 65 years or over ($M = 71.44$, $SD = 8.67$). They were recruited from the community in response to newspaper and email advertisements, fliers distributed via a range of organisations (e.g. Country Women's' Association, health clinics, Council On the Aging, various health clinics, and aged care activity centres). Two participants did not complete the Clock Drawing Test (CDT) and were not included in the analyses. The final sample size was 70 ($M_{age} = 71.47$; $SD = 8.79$). All participants were current drivers and held an open drivers' license.

Two groups of participants were formed based on their performance on the CDT (see Method). When Shulman et al.'s (1993) CDT cut-off was applied, 50 participants obtained CDT scores of 2 or below, indicating a pass on this screening test, and 20 participants obtained a CDT score of 3 or above, which suggests possible cognitive impairment. Participants' demographic information by group is shown in Table 1. This table presents the age, gender, residential location (urban versus rural), employment status and advanced driver training history of the sample.

Insert Table 1 about here

2.2. Materials.

2.2.1. Clock Drawing Test

The Clock Drawing Test is a screening test that relies on a range of cognitive abilities, including comprehension, memory, visuospatial abilities, abstract thinking and executive functioning (Shulman, 2000). The CDT correlates highly with other

cognitive screening tasks, such as the Mini-Mental State Examination (Samton et al., 2005; Royall et al., 1999), and it has been used in a variety of older driver studies to identify individuals who are more likely to make driving errors (Freund et al., 2005, 2008; Mathias & Lucas, 2009). The CDT was included in the package of questionnaires mailed to participants. Written instructions were provided at the top of a white A4 sheet of paper, printed with the outline of a circle in the middle of it. These instructions asked participants to draw a clock face in the circle by placing all of the required numbers, in their correct positions. In this study, participants were asked to draw the hands to indicate the time at 10 minutes after eleven. This instruction was chosen because previous research has suggested that it is sensitive to neurocognitive dysfunction (Freedman et al., 1994). The CDT was scored using the Shulman scoring method (Shulman et al., 1993). This scoring method was used because when compared to other scoring methods (Doyon et al., 1991; Tuokko et al., 1992; Watson et al., 1993; Wolf-Klein et al., 1989), the Shulman method produced high sensitivities (0.93) and high area under the ROC curve (0.79), making it particularly useful as a screening measure (Tuokko et al., 2000). Further, the Shulman method has high intra- and inter-rater reliability ($r = 0.9$ and 0.83 respectively), and correlates highly with other scoring methods (Tuokko et al., 2000). The Shulman scoring method ranks the clocks on a scale from 1 (“*perfect*”) to 6 (“*no reasonable representation of a clock*”)¹. Scores of 3 or above are suggestive of possible cognitive

¹ As per Shulman et al. (1993), the midpoints for the CDT classification are applied as follows: a score of 2 indicates “minor visuospatial errors”; a score of 3 indicates “inaccurate representation of 10 after 11 when visuospatial organization is perfect or show only minor deviations”; a score of 4 indicates “moderate visuospatial disorganization of times such that accurate denotation of 10 after 11 is impossible”; and a score of 5 indicates “severe level of disorganization as described in scoring of 4”; (see Shulman et al., 1993).

impairment, whereas scores of 1 and 2 are considered within normal limits (Shulman et al., 1986; 1993).

2.2.2. Driving Avoidance and Confidence

Participants' driving avoidance was measured by an extended version of the avoidance subscale of the Driver Mobility Questionnaire (DMQ-A) that was originally developed by Baldock et al. (2006). Revisions to the original DMQ-A have recently been suggested by Sullivan and colleagues (2011), hence twelve new items from the set generated by Sullivan et al. (2011) were added. These new items represent situations not covered in the original DMQ-A, but are ones that were perceived as potentially unsafe, and hence avoided, by older Australian drivers.

Participants were asked to rate on a 5-point Likert scale from 1 "*never*" to 5 "*always*", the extent to which they avoid driving in 21 potentially risky driving situations (such as at night or on freeways). This measure of overall driving avoidance was used as an index of participants' driving self-regulation. Driving confidence was assessed using the same scale as above, except that participants were instructed to rate on a 5-point Likert scale from 1 ("*never*") to 5 ("*always*"), the extent to which they felt confident driving in those situations².

Summary scores for participants' driving confidence and avoidance were derived by averaging scores on the 21 situations in each scale. Cronbach's alpha reliability analysis revealed both scales to have high internal consistency (driving confidence = .96; driving avoidance = .94).

2.2.3. Perceptions of health, driving performance and driving programs

² The midpoints on the confidence and avoidance were labelled as follows, 2 = "rarely", 3 = "sometimes", and 4 = "often."

Participants' health, driving habits and interest in older driver programs were also measured. To assess driving exposure, participants were asked to estimate the number of hours they drove per week over the last 3 years. Self-reported health and driving performance were assessed by asking respondents to rate their health and driving performance on 5 point Likert scales from 1 ("*very poor*") to 5 ("*excellent*")³. To assess intention to continue driving, participants were instructed to indicate on a scale 5 point Likert scale from 1 ("*strongly disagree*") to 5 ("*strongly agree*"), the extent to which they agreed with the statement "*I plan to continue driving in the foreseeable future*". To measure interest in older driver programs, participants were asked to rate on a scale from 1 "*strongly disagree*" to 5 "*strongly agree*", whether they think there is a need for information sessions targeted for older drivers⁴. In addition, respondents were asked to rate on a scale from 1 "*very unlikely*" to 5 "*very likely*", the likelihood that they would attend older driver programs⁵.

2.3. Procedure

Ethical clearance for this project was provided by the institutional review board (see Acknowledgements). Under the approved protocol, informed consent was inferred from the return of a completed questionnaire. Questionnaires were presented in 16-point font for ease of reading. A fixed-order battery was prepared and mailed to interested participants. In order of presentation, the battery assessed: a) demographic information, b) self-rated health and driving, c) intention to continue driving, d)

³ Health and driving performance were rated on 5-point Likert scales with the following midpoints: 2 = "poor", 3 = "fair", 4 = "very good" and 5 = "excellent".

⁴ Intention to continue driving and perception of need for information sessions were rated on 5-point Likert scales with the following midpoints: 1 = "strongly disagree", 2 = "disagree", 3 = "neither agree nor disagree", 4 = "agree" and 5 = "strongly agree".

⁵ Likelihood to attend information sessions was rated on a 5-point Likert scale with the following midpoints: 2 = "unlikely", 3 = "neutral", 4 = "likely" and 5 = "very likely".

driving confidence and avoidance, e) cognitive ability (CDT), and f) the need for, and participant's willingness to, attend older driver programs. Questionnaires were returned in a replied paid envelope.

3. Results

Data screening was undertaken prior to the main analysis. Missing data on measures were minimal therefore imputation not undertaken. A check of the distribution of CDT scores revealed that normality was breached. Non-parametric statistics were used to correct this breach. An alpha level of 0.05 was used to determine statistical significance, unless otherwise stated.

An initial check of the relationship between demographic factors and CDT performance was undertaken. Participants' age, but no other demographic variable, was found to be correlated with CDT scores, *Spearman's rho* = .52, $p < .001$. Two groups of participants were formed using Shulman et al.'s (1993) CDT cut-offs: participants who obtained scores of 1 ($n = 34$) and 2 ($n = 16$) were grouped into the "cognitively normal" group ($M_{CDT} = 1.32$, $SD = .47$), whereas participants who obtained scores of 3 ($n = 10$), 4 ($n = 4$), 5 ($n = 2$) and 6 ($n = 4$) were placed into the potential 'cognitive impairment' group ($M_{CDT} = 4.00$, $SD = 1.21$), following Shulman et al.'s (1986) categorization. Mean scale scores for these groups are shown in Table 2.

Insert Table 2 about here

Mann-Whitney (U) analyses were used to investigate group differences in driving exposure, self-rated health and driving performance, intention to continue driving, driving confidence and avoidance as well as likelihood of engaging in driving

programs. Compared to participants who obtained a CDT score within normal limits (two or less), those with higher CDT scores drove significantly more hours per week, $U = 338$, $Z = -2.12$, $p = .03$, with a medium effect size, $r = .25$, as per Cohen (1988). Both groups of participants rated themselves as of ‘good’ health, $U = 487$, $Z = -.19$, $p = .85$, $r = .02$, and believed their driving to be ‘good’, $U = 449$, $Z = -.76$, $p = .76$, $r = .08$. Similarly, there was no group difference in intention to continue driving in the foreseeable future, $U = 441$, $Z = -.59$, $p = .50$, $r = .08$. Interestingly, while there was no group difference in confidence ratings (on average, both groups were ‘very’ confident in a range of high-risk driving situations), $U = 440.50$, $Z = -.78$, $p = .44$, $r = .09$, those that failed the cognitive screen were significantly less likely to avoid these driving situations, $U = 336.50$, $Z = -2.14$, $p < .03$, with a medium effect size $r = .26$. Further, while both groups of participants ‘agreed’ that there was a need for information for older drivers, $U = 449$, $Z = -.72$, $p = .72$, $r = .09$, those that failed the cognitive screen were significantly less willing to attend driving programs than those who passed the CDT, $U = 262.5$, $Z = -3.42$, $p = .001$, with a medium effect size, $r = .38$.

4. Discussion

The present study explored the relationship between cognitive ability, driving confidence, driving self-regulation, and perceived need for information for older drivers and willingness to attend driving programs. The current study is, to the authors’ knowledge, the first to examine the relationship between these factors. With significant growth internationally predicted in the number of older drivers, the need for this research is clearly evident.

The results of this study show that, regardless of cognitive ability, this sample of older drivers thought that they possessed good health and driving abilities, were

confident driving in a range of potentially hazardous situations, recognised a need for older driver information, and reported similar intentions with respect to continued driving. These results are consistent with previous findings that showed older drivers typically report positive views towards their health and driving abilities (Charlton et al., 2006; Marottoli & Richardson, 1998; Molnar & Eby, 2008).

Compared to those people who passed the cognitive screen, those who demonstrated possible cognitive impairment reported driving significantly fewer hours per week. This result is consistent with previous findings that show that older drivers, especially those with functional declines tend to quantitatively limit their driving as part of a gradual process of driving cessation (Hakamies-Blomqvist & Wahlstrom, 1998). In addition, even though there was a statistically significant group difference in the degree of self-regulation (avoiding specific driving situation), the extent to which people were avoiding specific driving situations was generally low. This finding fits with the recent report by Sullivan et al. (2011) that showed that, on average, older Australian drivers did not report avoiding driving in ‘potentially’ hazardous driving situations.

More broadly, the relationships between participants’ cognitive ability, driving confidence and self-regulation identified in this study are consistent with the findings by MacDonald and colleagues (2008). These authors showed that older drivers’ self-regulatory behaviour was more strongly related to self-perceived driving abilities than to objective driving abilities. Furthermore, drivers who demonstrated greater discrepancies between driving confidence and actual abilities (indicating lack of insight) were less likely to self-regulate their driving. This result has important practical implications as previous research suggests that drivers who overestimate

their abilities may be more likely to place themselves in situations that exceed their limitations (Marotolli & Richardson, 1998; MacDonald et al., 2008).

Whilst the current sample of older drivers generally agreed that driving programs for older adults were needed, compared to the CDT – defined “normal” group, those who demonstrated possible cognitive impairment reported being significantly less likely to attend such programs. The reluctance of those drivers who failed the cognitive screen to attend driving programs suggests that if this group is to be involved in such programs, other means, apart from self-referral, may need to be explored. These means could include involving family members or friends (if appropriate) as a means of facilitating engagement.

This study has a number of limitations. It should be noted that the sampling strategy that was used (advertising for volunteer participants) may have resulted in the sampling of keen and active drivers. Indeed, a previous qualitative study by Adler and Rottunda (2006) identified a group of older drivers who they called “resisters” (drivers who have unrealistic perceptions about their driving skills, and continue to drive until they are forced to stop), and this group were unlikely to participate in studies. However, the present sample shares similar demographics characteristics with other older driver studies. For example, in terms of cognitive ability, Freund and colleagues (2005) reported that 24% of their older driver sample failed the CDT, a rate similar to that found in the current study (28.57%). Also, compared to the study by Ross and colleagues (2009), which had a bigger sample of slightly older Australian older drivers ($n = 2834$) than this study, the proportion of the sample that was classified as having probable or possible cognitive impairment based on the MMSE was similar in both of these studies (34.8% Ross et al., 2009 compared to 28.57% this study, based on the CDT).

While the CDT is a measure of cognitive ability that is sensitive to cognitive impairment (Sunderland et al., 1989; Wolf-Klein, Silverstone, Levy, Brod & Breuer, 1989), and has been shown to discriminate between people who performed well versus those that perform poorly on a simulated driving task (Mathias & Lucas, 2009), this test is not a comprehensive measure of cognitive ability. A recent literature review indicates that while the CDT can accurately screen for moderate and severe dementia, its sensitivity is considerably lower when applied to patients with mild or questionable dementia (Pinto & Peters, 2009). Further, whilst the effect of education as a moderator on CDT performance is reported to be comparatively small (Shulman et al., 2000), this factor was not controlled for in this study. The CDT was also self-administered and because this administration method was used it is possible that some participants were misclassified. Follow-up studies should adopt a more rigorous test of cognitive ability to further investigate and quantify the relationship between cognitive ability and key driving variables.

A related limitation is that self-report measures were used to assess driving and health-related variables. The problem of the reliability of data for these variables may be further compounded in the present study by the inclusion of people who failed the cognitive screening test. Any conclusions in regards to participants' self-rated driving must be further tempered by the fact that this construct was assessed with a single-item. While driving confidence in specific driving-related situations was also gauged, and revealed similar pattern of results, future studies of the relationship between cognitive ability, driving confidence and self-regulatory behaviors could consider using instruments that measure perceived driving abilities in specific domains, such as the Perceived Driving Abilities Scale (MacDonald et al., 2008). In addition, given the findings of a recent study by Blanchard and colleagues (2010) who

found a lack of correlation between self-reported and actual driving practices, triangulation of multiple driving data sources is important for future research.

There are several implications that arise from this study that relate to older driver safety, and in particular, the notion of driving self-regulation. An important general finding is that the majority of participants in this study passed the cognitive screen, reported self-regulating their driving (for example, by avoiding driving at night and at high trafficked times) and were willing to attend driving programs. However, about one third of this sample failed the cognitive screen, and there were significant group differences between those who failed this test versus those who passed it. Specifically, those that failed the cognitive screen reported driving less and avoiding fewer 'dangerous' situations (less self-regulation), and were less willing to attend a driving program. Whether the relative decrease in driving reported by those participants who failed the cognitive screen as opposed to those who passed it, can be understood as self-regulation is difficult to determine. It is possible that, as noted by other researchers (e.g., Ball et al., 1998; Myers et al., 2008; Blanchard & Myers, 2010; Sullivan et al., 2011), changes (such as reduced driving at night or on highways) may be due to changes in lifestyles (such as reduced overall night-time activities) as opposed to purposeful self-regulation. It is also possible that those people who failed the cognitive screen were less able to articulate the *nature* of the changes to their driving that they have made (i.e., to identify the specific situations that they now avoid) as opposed to reporting a more general change in driving (i.e. driving less). Further research is clearly needed to further unpack the complex relationships between these variables, and to determine the impact of cognitive function on objective self-regulation and on-road driving safety.

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Table 1: *Sample characteristics (N = 70)*

Sample characteristic	CDT ≤ 2		CDT ≥ 3		Total	
	(n = 50)		(n = 20)		(N = 70)	
Age (<i>M/SD</i>)	69.98	(7.44)	75.95	(10.41)	71.47	(8.79)
Gender						
Male	30%		50%		35.7%	
Female	70%		50%		64.3%	
Employment						
Not employed/ no voluntary work			10%		2.9%	
Not employed/ voluntary work	4%		20%		8.6%	
Retired	84%		50%		74.3%	
Part time	8%		20%		11.4%	
Full time	4%				2.9%	
Years licensed (<i>M/SD</i>)	49.96	(5.08)	52.60	(12.75)	20.71	8.03
Advanced driver training						
Yes	16%		0%		88.6%	
No	84%		100%		11.4%	
Predominant driving environment						
City	8%		0%		5.7%	
Suburban	16%		30%		20%	
Rural	8%		20%		11.4%	
Mixed	68%		50%		62.9%	
Residential location						
Major city	30%		30%		30%	
Inner Regional	32%		40%		34.3%	
Outer Regional	36%		20%		31.4%	
Remote	0%		10%		2.9%	
Very remote	2%		0%		1.4%	

Notes: CDT = Clock drawing test; Shulman et al.'s (1993) CDT cut-off was used: CDT scores of 2 or less indicate a pass on this screening test. Scores of 3 or more = failed screen for cognitive impairment. Predominant driving environment and residential location was assessed by self-report.

Table 2: *Participants' driving regularity, confidence and avoidance, self-rated health and driving abilities, and interest in driving information and programs by CDT scores (N = 70)*

	CDT ≤ 2		CDT ≥ 3		Total	
	(n = 50)		(n = 20)		(N = 70)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Driving regularity (hrs/wk)*	10.45	6.31	7.20	5.18	9.42	6.10
Self-rated health	3.14	.64	3.10	.72	3.13	.65
Self-rated driving	3.02	.65	3.15	.59	3.06	.63
Continue driving	4.69	.48	4.60	.94	4.64	.64
Driving confidence	4.31	.70	4.25	.96	4.27	.78
Driving avoidance *	1.77	.78	1.43	.54	1.70	.75
Need for future programs	3.94	.91	4.10	.85	3.99	.88
Likelihood to attend programs*	3.00	1.01	2.10	.97	2.74	1.10

Notes: CDT = Clock drawing test; Shulman et al.'s (1993) CDT cut-off was used: CDT scores of 2 or less indicate a pass on this screening test. Scores of 3 or more = failed screen for cognitive impairment.

* $p < .05$