Executive Functioning and Gambling: Performance on the Trail Making Test is Associated with Gambling Problems in Older Adult Gamblers

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ABSTRACT

Rates of gambling problems in older adults have risen with increased accessibility of gambling venues. One possible contributor to problem gambling among older adults is decreased self-control brought about by diminished executive functioning. Consistent with this possibility, Study 1 revealed that older adults recruited from gambling venues reported greater gambling problems if they also experienced deficits in executive functioning, measured via the Trail Making Test. Study 2 replicated this finding and demonstrated that problem gambling is associated with increased depression among older adults, mediated by increased financial distress. These studies provide support for the hypothesis that older adult gamblers who have executive functioning problems are also likely to have gambling problems.

Keywords: Executive functioning; Mental set shifting; Inhibition; Problem gambling; Self-control.

INTRODUCTION

Over the past 30 years the percentage of adults over the age of 65 who gamble has risen dramatically – more than doubling in some locales – and rates of problem gambling have risen as well, particularly in populations with easy access to casinos and other forms of betting (Petry, 2005). It is unclear from these trends, however, why gambling problems are increasing among older adults. It could
be the case that the increased accessibility of gambling, in combination with the
availability of leisure time and expendable income, leads some older adults to
develop gambling problems. Alternatively, it is possible that gambling prob-
lems in older adults are at least partially the result of age-related atrophy of the
frontal lobes leading to diminished executive functioning.

In late adulthood the total volume and weight of the brain gradually
reduces as neurons and the connections between neurons shrink in size,
thereby making them less effective (Tang, Whitman, Lopez, & Baloh, 2001).
One area of the brain that shows substantial atrophy with age is the prefrontal
cortex (Raz & Rodrigue, 2006). Because the prefrontal cortex is the cortical
region primarily responsible for executive functioning, which includes con-
trol of thought and action (Banfield, Wyland, Macrae, & Heatherton, 2004;
Koechlin, Ody, & Kouneiher, 2003; Miller & Cohen, 2001), atrophy of this
region of the brain can lead to deficits in self-control (Raz & Rodrigue,
2006; Stuss & Knight, 2002; West, 1996). For older adults who gamble,
losses in the ability to control their behavior may lead to excessive or patho-
logical gambling (see Potenza et al., 2003).

Consistent with such a possibility, executive dysfunction has been
documented among young adult pathological gamblers (Goudriaan, Oosterlaan,
de Beurs, & van den Brink, 2006), suggesting that executive control may play
a role in curtailing excessive gambling. Poor executive control has also been
associated with a more impulsive decision making style, in which people
with poorer executive functioning show greater discounting of delayed
rewards (Hinson, James, & Whitney, 2003). This finding suggests that exec-
utive control may be important in a variety of decision making tasks in
which people must weigh current costs and benefits against future or distant
consequences. Gambling is one such task, in which the current desire to
gamble must be balanced against future costs should the likely outcome of
monetary losses emerge. Because deficits in executive control are a common
consequence of normal adult aging (Hasher, Zacks, & May, 1999; West,
1996), many older adults who gamble are likely to experience losses in their
ability to control their gambling behavior. That is, as a consequence of
normal age-relate declines in executive functioning, older adults might find
it increasingly difficult to control their urge to gamble, and might find them-
se themselves betting more money or more frequently than they should.

Although there is no direct evidence to support such a possibility, exec-
utive decline in late adulthood has been shown to predict losses of self-control
in other domains (von Hippel, 2007). For example, age-related deficits in
executive control have been implicated in age-related increases in off-target
verbosity (Pushkar et al., 2000), socially inappropriate behavior (Henry, von
Hippel, & Baynes, in press; von Hippel & Dunlop, 2005), and stereotyping
and prejudice (Henry et al., in press; Stewart, von Hippel, & Radvansky,
2009; von Hippel, Silver, & Lynch, 2000). Indeed, individual differences in
executive control have also been linked to socially inappropriate behavior among young adults (von Hippel & Gonsalkorale, 2005; see also von Hippel et al., 2000), suggesting that executive functioning can play an important role in self-control independent of general cognitive decline.

It is important to note, however, that poor executive functioning is unlikely to predict gambling problems among all older adults. Rather, executive control should only predict gambling problems among those individuals who have an urge to gamble. Those older adults who do not gamble or who have very little interest in gambling are unlikely to show a relationship between executive dysfunction and problem gambling, as they are unlikely to have a desire to gamble that must be restrained. So although most older adults show declining executive functioning, these declines in executive functioning are expected to cause gambling problems only in those older adults who are active in gambling. Thus, the primary hypothesis of the current research is that older adults who gamble will show increasing gambling problems to the degree that they also show decreasing executive functioning.

Two studies were conducted to test this hypothesis. In both studies older adults were recruited from gambling establishments to ensure that all participants engaged in at least occasional gambling activities. Participants were then given a measure of executive functioning (described below) and a self-report measure of gambling problems. If executive decline leads to gambling problems, then an association should emerge in this sample of older adult gamblers between a measure of executive functioning and problem gambling. The goal of Study 1 was to establish whether such an association exists. The goal of Study 2 was to assess the reliability of such an association, and also to assess whether self-reported gambling problems in this sample are related to the types of financial and mental health problems typically associated with problem gambling. In combination, these studies were intended to provide evidence that among older adults who gamble, poorer executive functioning is associated with an increased likelihood of experiencing gambling problems and the attendant difficulties that such problems entail. Such a pattern of findings would be a first step in establishing that executive decline actually causes gambling problems among older adult gamblers.

Both of these studies relied on a measure of executive functioning known as the Trail Making Test (TMT; Army Individual Test Battery, 1944). Part A of the TMT requires participants to draw a line from the numbers 1 to 25 in consecutive order. Part B requires participants to draw a line from 1 to A to 2 to B, etc., until 24 lines have been drawn. The primary measure of executive functioning in the TMT is the increase in time taken to complete Part B compared to Part A, as Part B requires participants to inhibit the tendency to move from number to number, or letter to letter, as they must repeatedly switch back and forth between numbers and letters. Differential performance on Part B vs. Part A has been associated with set shifting.
performance (Arbuthnott & Frank, 2000) and with perseverative errors on the Wisconsin Card Sorting Task (Kortte, Horner, & Windham, 2002). These findings, and indeed a substantial research literature with the TMT, suggest that poor performance on the TMT can be considered an indicator of the tendency to perseverate in one response mode and to have difficulty shifting from one mental set to another. These aspects of the TMT make it well suited for the current research, as problem gambling is defined as ‘persistent and recurrent maladaptive gambling behavior characterized by an inability to control gambling’ (APA, 1994). Thus, the lack of executive control that makes set switching on the TMT difficult for some older adults may also make it more difficult for them to control their perseverative (i.e., persistent and recurrent) gambling. If so, then a relationship should emerge between performance on the TMT and gambling problems among older adults who gamble.

STUDY 1

Study 1 assessed whether the TMT correlates with gambling problems among older adults who gamble. Participants were recruited at a gambling establishment, and the study itself was conducted on the premises of the establishment. To avoid interrupting patrons of the establishment for longer than necessary, all measures were chosen with brevity in mind. The primary measures were a self-report gambling problems scale and the TMT. Because executive functioning is related to impulsivity (Hinson et al., 2003; Nigg, 2000), and because impulsivity is strongly related to gambling problems (Steel & Blaszczynski, 1998), this experiment also included a measure of impulsivity. If the TMT predicts gambling problems beyond their mutual relationship with impulsivity, then the TMT should account for variance in gambling problems independent of that predicted by impulsivity.

Method

Participants

Sixty-four older adults (age 60–85, $M = 70.9$, $SD = 6.6$; 45 female) were recruited from people playing poker machines in Sydney, Australia, and paid $20$ AUD ($\sim$15 US) for their participation. The study itself was conducted in a quiet area on the gambling premises.

Procedure

Participants first completed a demographic scale that included age, gender, and education. Because the most commonly used self-report scale for gambling problems – the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987) – has a number of items that are inappropriate for older adults
who may have only recently developed gambling problems, 6 items were chosen from this scale and an additional five items were chosen from the Gambler’s Anonymous Scale. The scoring of the items was also changed from yes/no to a 5-point scale with the verbal labels of Never, Rarely, Sometimes, Often, and Very Often. Scores were averaged to form a gambling problems scale with a possible range from 1 to 5 ($M = 1.99$, $SD = .90$, $a = .94$). Participants then completed a 10-item version of the Eysenck impulsivity scale (Eysenck & Eysenck, 1991) in which items were chosen that seemed most relevant to older adults. Responses to these items were provided on the same scale as the revised gambling scale ($M = 2.42$, $SD = .53$, $a = .74$).

Participants then completed the Trail Making Test. To minimize the impact of processing speed on the TMT performance, a residual score was computed such that the variance in Part B accounted for by Part A was removed from the measure. This residual score was computed by regressing Part B onto Part A, and then saving the unstandardized residual from this analysis to serve as the measure of TMT performance.\(^1\)

**Results**

Analyses revealed that the gambling problems scale was correlated with impulsivity ($r = .49$, $p < .001$) and marginally correlated with the residual TMT ($r = .23$, $p = .07$). Impulsivity was uncorrelated with the residual TMT ($r = .02$, $ns$). To assess whether the TMT predicted independent variance in gambling problems beyond that accounted for by impulsivity, age, gender, and education, the gambling problems scale was regressed on residual TMT, impulsivity, age, gender, and education. This analysis revealed that impulsivity ($\beta = .41$, $p = .001$) and the residual TMT ($\beta = .26$, $p < .05$) both accounted for independent variance in gambling problems. No other variables were significant predictors in this analysis.

**Discussion**

Consistent with predictions, an association emerged between the TMT and self-reported gambling problems among older adults recruited from a gambling establishment. Furthermore, the association between the TMT and gambling problems was independent of the relationship between these variables and impulsivity. Nevertheless, several questions remain. First, it was unclear whether the TMT accounts for variance in gambling problems independent of the frequency with which people gamble. In Study 1 participants reported on their gambling problems, but not the frequency with which they gamble, and thus it is impossible to know if the TMT is associated with gambling problems

\(^1\)The results were functionally identical when raw scores were used for the TMT in both studies.
independent of the actual frequency with which people gamble. To address this issue, participants in Study 2 were asked how much they play poker machines. If poor executive functioning manifests itself in more frequent gambling, then the TMT would be unlikely to account for unique variance in gambling problems beyond a measure of gambling frequency. In contrast, if poor executive functioning leads to gambling problems independent of gambling frequency, then the two measures should account for independent variance in gambling problems. Additionally, to ensure that poker machine playing was not just a proxy for time spent at the gambling establishment, participants were also asked how much they play bingo. Poker playing was expected to predict gambling problems, but bingo is less likely than poker machines to be associated with gambling problems (Productivity Commission, 1999). As a consequence, if the measures assess actual time spent gambling, then time spent playing poker should be predictive of gambling problems but time spent playing bingo should not.

Second, no evidence was provided for the validity of the gambling problems scale. If self-reported gambling problems are of importance among older adults, they are likely to be associated with financial difficulties (APA, 1994), which in turn have the potential to lead to depression (Battersby, Tolchard, Scurrah, & Thomas, 2006; MacDonald, McMullan, & Perrier, 2004). Thus, Study 2 included measures of financial difficulties and depression.

Third, gambling problems have also been associated with superstition (Raylu & Oei, 2004), and superstition has been linked to poor executive functioning (Wain & Spinella, 2007). If executive control is a unique predictor of gambling problems, it should also account for variance in gambling problems beyond that predicted by superstition. Finally, no measure was taken in Study 1 to ensure that participants were not suffering from incipient dementia. To address this concern, participants in Study 2 were given the Mini-Mental Status Exam (MMSE; Kukull et al., 1994), thereby enabling an assessment of whether the TMT is associated with gambling problems among people who do and do not show signs of incipient dementia.

STUDY 2

Method

Participants

One hundred and sixty-five older adults (age 60–94, 99 female) were recruited from people playing bingo or poker machines at gambling sites in Brisbane, Australia, and paid $20 AUD (~$15 US) for their participation.

Procedure

Participants first completed a demographic scale as in Study 1. The order of the remaining measures was counterbalanced, with the exception of
the measure of financial distress and the dementia screening (which were given last). To assess frequency of gambling, participants indicated, on 5-point scales that ranged from *Never* to *Daily*, how often they play bingo and poker machines. Participants also indicated how much time they typically spend playing bingo and poker machines. The latter questions were responded to on a 5-point scale that ranged from *None* to *Over 6 hours*. To assess executive functioning, participants completed the TMT as in Study 1.

To tap a wide variety of superstitious beliefs, participants completed a 15-item superstition scale that was composed of items from the Superstitious Beliefs in Gambling Scale (Joukhador, Blaszczynski, & Maccallum, 2004), the Predictive Control subscale of the Gambling Related Cognitions Scale (Raylu & Oei, 2004), and a few items based on observations of poker machine gamblers (e.g., ‘When I’m playing the pokies [poker machines], I sometimes feel a big win is coming up and I want to stay on my machine rather than switch or take a break.’). Responses were provided on a *yes/no* format, and scores were summed to form a scale with a possible range of 0 to 15 ($a = .79$). Participants also completed a 6-item version of the impulsivity test from Study 1, with responses provided on a *yes/no* format, and scores were summed to form a scale with a possible range from 0 to 6 ($a = .64$).

To assess gambling problems, participants also completed a 10-item version of the SOGS, which was used in place of the blended gambling problems scale from Study 1. The 10 items chosen for administration only referred to consequences and problems with gambling, and did not explicitly ask about frequency of gambling (e.g., ‘Have people criticized your betting or told you that you had a problem, regardless of whether you thought it was true?’). Responses were provided on a *yes/no* format, and scores were averaged to form a scale with a possible range from 0 to 1 ($a = .77$). Participants also completed a 3-item version of the InCharge Financial Distress Scale (Prawitz et al., 2006). Responses were provided on 7-point scales, and scores were averaged to form a scale with a possible range from 1 to 7, with higher scores indicating greater financial distress ($a = .83$).

To assess depression, participants completed a 14-item version of the Geriatric Depression Scale (GDS; Sheikh & Yesavage, 1986). Responses were provided on a *yes/no* format, and scores were summed to form a depression scale with a possible range of 0 to 14 ($a = .73$). The final task for participants was dementia screening, which relied on the Mini-Mental Status Exam (MMSE; $M = 26, SD = 3.23$). Participants with scores greater than 26 out of 30 are considered to be of normal mental status (i.e., showing no sign of dementia; Kukull et al., 1994).\(^2\)

\(^2\)The reliabilities reported above were computed with the full sample. Reliabilities with the sub-sample scoring higher than 26 on the MMSE were equivalent or higher than these.
Results

In the current sample, 84 participants scored above 26 on the MMSE. Because almost half the sample showed signs of possible dementia, the analyses were conducted with the entire sample, but are also reported separately with the subsamples that scored above 26 and that scored 26 or less whenever those subsamples differed from each other. Descriptive statistics for both subsamples are presented in Table 1. The only variables to differ significantly by MMSE classification were age and impulsivity ($p < .05$). Correlations between all of the variables were then computed separately for the two subsamples (see Table 2).

As can be seen in Table 2, the gambling problems scale was correlated with frequency of playing the poker machines in both subsamples and with time spent playing poker machines among the high MMSE subsample. Gambling problems were not correlated with frequency or time spent playing bingo in either subsample. Gambling problems were correlated with impulsivity only in the low MMSE subsample and with financial distress only in the high MMSE subsample. In none of these cases was the difference between the correlations significant across the two subgroups ($z_s < 1.42$, $p_s > .15$). Gambling problems were not significantly correlated with the GDS in either subsample, but this relationship was significant when collapsed across both subsamples ($r = .26$, $p = .001$). Gambling problems were also correlated with superstition in both subsamples. Gambling problems were only significantly correlated with the residual TMT in the high MMSE subsample, although the difference between the correlations did not approach significance ($z = .23$, $p > .80$). Gambling problems were not correlated with scores on the MMSE when collapsed across both subsamples ($r = .10$, $p > .20$).

| Table 1. Descriptive Statistics for the Variables in Study 2, as a Function of MMSE Scores |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
|                                | MMSE ≤ 26 Mean | MMSE ≤ 26 SD    | MMSE > 26 Mean | MMSE > 26 SD    |
| Age                            | 71.16           | 6.38            | 68.40           | 6.55            |
| Poker time                     | 2.73            | .94             | 2.73            | .95             |
| Poker frequency                | 2.74            | .99             | 2.89            | 1.13            |
| Bingo time                     | 1.55            | .97             | 1.82            | 1.09            |
| Bingo frequency                | 1.62            | 1.11            | 1.95            | 1.20            |
| Gambling problems              | .19             | .16             | .24             | .21             |
| Financial distress             | 3.28            | 1.14            | 3.01            | 1.32            |
| Depression                     | .16             | .15             | .17             | .17             |
| Residual TMT                   | −1.90           | 28.93           | .81             | 35.60           |
| Impulsivity                    | 2.35            | 1.56            | 3.02            | 1.75            |
| Superstition                   | .22             | .20             | .23             | .21             |
Table 2. Correlations Between Variables in Study 2, as a Function of MMSE Scores (MMSE > 26 above diagonal, MMSE ≤ 26 below diagonal)

<table>
<thead>
<tr>
<th>Age</th>
<th>Poker time</th>
<th>Poker frequency</th>
<th>Bingo time</th>
<th>Bingo frequency</th>
<th>Gambling problems</th>
<th>Financial distress</th>
<th>Depression</th>
<th>Residual TMT</th>
<th>Impulsivity</th>
<th>Superstition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>- .19</td>
<td>- .18</td>
<td>.03</td>
<td>- .01</td>
<td>- .05</td>
<td>- .09</td>
<td>.00</td>
<td>.05</td>
<td>- .03</td>
<td>.12</td>
</tr>
<tr>
<td>Poker time</td>
<td>.17</td>
<td>.44***</td>
<td>- .01</td>
<td>- .12</td>
<td>.37***</td>
<td>.14</td>
<td>.12</td>
<td>.01</td>
<td>- .12</td>
<td>.18</td>
</tr>
<tr>
<td>Poker frequency</td>
<td>- .10</td>
<td>.36**</td>
<td>- .24*</td>
<td>- .32**</td>
<td>.35**</td>
<td>.10</td>
<td>- .03</td>
<td>.00</td>
<td>- .05</td>
<td>.16</td>
</tr>
<tr>
<td>Bingo time</td>
<td>- .11</td>
<td>- .23</td>
<td>- .31*</td>
<td>.79***</td>
<td>- .10</td>
<td>.06</td>
<td>.22*</td>
<td>.08</td>
<td>- .04</td>
<td>.08</td>
</tr>
<tr>
<td>Bingo frequency</td>
<td>- .12</td>
<td>- .12</td>
<td>- .34**</td>
<td>.92***</td>
<td>- .10</td>
<td>.01</td>
<td>.17</td>
<td>.04</td>
<td>- .10</td>
<td>.09</td>
</tr>
<tr>
<td>Gambling problems</td>
<td>- .02</td>
<td>.18</td>
<td>.30*</td>
<td>.03</td>
<td>- .01</td>
<td>.34**</td>
<td>.19</td>
<td>.23*</td>
<td>.04</td>
<td>.30**</td>
</tr>
<tr>
<td>Financial distress</td>
<td>- .03</td>
<td>.01</td>
<td>- .16</td>
<td>.14</td>
<td>.11</td>
<td>.44***</td>
<td>.04</td>
<td>.15</td>
<td>.20</td>
<td>.20</td>
</tr>
<tr>
<td>Depression</td>
<td>- .03</td>
<td>.12</td>
<td>- .03</td>
<td>.05</td>
<td>.23</td>
<td>.03</td>
<td>.20</td>
<td>.06</td>
<td>.12</td>
<td>.12</td>
</tr>
<tr>
<td>Residual TMT</td>
<td>.06</td>
<td>.00</td>
<td>.34**</td>
<td>- .23</td>
<td>- .24</td>
<td>.19</td>
<td>.03</td>
<td>.05</td>
<td>- .03</td>
<td>.04</td>
</tr>
<tr>
<td>Impulsivity</td>
<td>- .20</td>
<td>.18</td>
<td>.20</td>
<td>.10</td>
<td>.25*</td>
<td>- .25*</td>
<td>.09</td>
<td>.09</td>
<td>- .03</td>
<td>.04</td>
</tr>
<tr>
<td>Superstition</td>
<td>.10</td>
<td>.19</td>
<td>.20</td>
<td>- .11</td>
<td>- .14</td>
<td>.29*</td>
<td>- .01</td>
<td>.12</td>
<td>.29*</td>
<td>.20</td>
</tr>
</tbody>
</table>
To assess whether the TMT accounted for independent variance in gambling problems (beyond that accounted for by impulsiveness, superstition, frequency/time spent playing poker machines, and the MMSE), and whether gambling problems had downstream consequences for financial distress and depression, a regression-based causal model was estimated following the procedures outlined in Baron and Kenny (1986). Age, gender, and education were also included as control variables in this model (none of which predicted unique variance in gambling problems). In the first step of the model, scores on the SOGS were regressed on impulsiveness, superstition, frequency/time spent playing poker machines, the MMSE, the residual TMT, and age, gender, and education. Consistent with predictions, the TMT was found to account for independent variance in gambling problems, beyond that accounted for by all other variables (see Figure 1). When this regression equation was run separately in the high and low MMSE subsamples, the residual TMT measure accounted for independent variance in gambling problems in the high MMSE subsample ($\beta = .26, p < .02$), but not in the low MMSE subsample ($\beta = .04, p > .80$).

**Figure 1.** Regression-based path analysis of the effects of poker machine playing, executive functioning, impulsivity, and superstition on gambling problems, and the subsequent mediated impact of gambling problems on depression via financial distress. Path coefficients are standardized regression weights. The coefficient in parentheses between gambling problems and depression represents the direct effect when the mediator is included in the model, the coefficient not in parentheses represents the direct effect when the mediator is not included in the model. Gender, age, education, and scores on the Mini-Mental Status Exam were included in the model as control variables, but were not significant predictors of gambling problems, and thus are not displayed in the figure. Note: *$p < .05$; **$p < .01$. 

<table>
<thead>
<tr>
<th>Time spent Playing Poker</th>
<th>Frequency Playing Poker</th>
<th>Residual TMT Scores</th>
<th>Impulsivity</th>
<th>Superstition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>.19*</td>
<td>.18*</td>
<td></td>
</tr>
<tr>
<td>Financial Distress</td>
<td></td>
<td>.18*</td>
<td>.21*</td>
<td>.21*</td>
</tr>
<tr>
<td>Depression</td>
<td></td>
<td>.28*</td>
<td>.28*</td>
<td>(.22*)</td>
</tr>
</tbody>
</table>

Downloaded By: [von Hippel, William] [University of Queensland] At: 02:26 20 October 2009
In the second step of the model, financial distress was regressed on impulsiveness, superstition, frequency/time spent playing poker machines, the MMSE, the residual TMT, the SOGS, and age, gender, and education. Consistent with predictions, gambling problems predicted financial distress. In the third and fourth steps of the model, depression was regressed on all of these variables either with (step 3) or without (step 4) financial distress as a predictor. Consistent with predictions, these analyses revealed that financial distress mediated the impact of gambling problems on depression (see Figure 1). A Sobel test revealed that this mediational pathway was significant \((z = 2.03, p < .05)\). The results of the entire model were essentially equivalent (although slightly stronger) when the model was estimated only with participants with MMSE scores greater than 26. Additionally, when competing models were examined by reordering the variables, no evidence for significant mediation emerged.

**Discussion**

The results of Study 2 provide further evidence that the TMT is associated with gambling problems among older adults. In this study, older adults who performed poorly on this measure of executive functioning also reported greater gambling problems. Furthermore, these self-reported gambling problems were associated with financial distress, which in turn predicted depression. These findings suggest that the self-reported gambling problems of these older adults were significant in nature, and were having an impact on other important aspects of their lives. Although these findings await corroboration with longitudinal data, they provide suggestive evidence that decline in executive control among older adults can lead to substantial gambling problems and to subsequent financial difficulties and mental health problems.

The results of Study 2 also address the possibility that it was incipient dementia that underlies the relationship between executive functioning and gambling problems. In Study 2 the relationship between the TMT and gambling problems was non-significantly stronger among older adults who performed better on the cognitive screening test compared to older adults whose scores suggested possible dementia. Thus, it seems to be the case that executive functioning plays at least as much of a role in gambling problems among people whose cognitive functioning is otherwise intact as it does among people who might be suffering from dementia. Additionally, the relationship between gambling problems and financial distress emerged primarily among participants who showed no signs of incipient dementia. Thus, it seems possible that gambling problems may be only one of many sources of financial hardship for people who, by virtue of their cognitive deficits, are likely to have difficulty controlling their finances.

The findings of Study 2 also suggest that the association between executive functioning and gambling problems exists independently of individual
differences in impulsivity or superstition. Although superstition was a stronger predictor of gambling problems than any of the other variables, executive functioning nevertheless accounted for significant variance beyond that explained by levels of superstition. This finding suggests that the type of executive control tapped by the TMT is associated with gambling problems in a manner that is independent of the type of disordered thinking evident in superstition.

Lastly, it should also be noted that the TMT predicted problem gambling independent of the frequency and duration that participants played the poker machines. Although frequency and duration of poker playing were themselves predictors of gambling problems, it seems to be the case that poor executive functioning is not associated with gambling problems because people who have difficulty with the TMT play more often or for longer durations. Rather, it appears to be the case that poor executive functioning is associated with worse gambling decisions. It remains a question for future research whether poor executive functioning is associated with making larger bets, persevering at gambling in the absence of wins, or other possible behaviours that are associated with gambling problems.

GENERAL DISCUSSION

The findings from two studies provide evidence for the role of executive functioning in problem gambling in older adults. In both studies, older adults who showed poor executive functioning on the Trail Making Test were more likely than older adults who showed good executive functioning to report gambling problems. In Study 1 this relationship was independent of individual differences in impulsiveness, suggesting that executive functioning was related to gambling problems independent of the relationship between executive functioning and impulsivity. Study 2 replicated this finding and also went beyond Study 1 in several important ways.

First, Study 2 demonstrated that the relationship between executive functioning and gambling problems was independent of individual differences in superstition, suggesting that executive functioning was related to gambling problems independent of the relationship between executive functioning and the type of disordered thinking evident in superstition. Second, Study 2 revealed that the relationship between executive functioning and gambling problems was also independent of frequency and amount of gambling, suggesting that poor executive control is not related to gambling problems through a mutual relationship with gambling frequency or amount. Third, Study 2 went beyond Study 1 by demonstrating that these self-reported gambling problems appear to be important, as they were associated with self-reported financial distress and depression. Fourth, Study 2 demonstrated that the relationship between executive functioning and
gambling problems emerged among people whose scores on a cognitive screening test suggest that they do not suffer from incipient dementia, and indeed this relationship appeared stronger among these individuals than among people whose scores suggest dementia as a possibility.

Although the current research does not indicate why executive functioning might be more strongly associated with gambling problems among people who show fewer signs of dementia, there are some relevant hints in the data. First, it does not seem to be the case that restriction of range among people with low scores on the MMSE is the source of possible differences. As can be seen in Table 1, the means and standard deviations for the various measures are highly comparable in the two subsamples. Second, an alternative possibility is that people with higher MMSE scores might be more capable of accurately reporting their degree of gambling problems. Consistent with this possibility, the gambling problems scale was (nonsignificantly) more strongly correlated with time spent playing the poker machines among people with MMSE scores greater than 26 than among people with MMSE scores less than or equal to 26. Inconsistent with this possibility, however, gambling problems were (nonsignificantly) more strongly correlated with impulsiveness among people with low rather than high MMSE scores. Furthermore, gambling problems were significantly correlated with frequency of poker machine playing and with superstition in both groups of participants. Thus, at this point it is unclear if there really is a difference between the two subsamples, and if so, what the cause of it might be. Future research might untangle this problem by including objective corroboration of self-reported gambling problems among people with low vs high MMSE scores and/or other indicators of incipient dementia.

The findings from these studies are consistent with predictions, but there are weaknesses in the current approach that must be noted. First and most importantly, the results were cross-sectional and correlational, and thus it is impossible to rule out other causal patterns, or the possibility that the relationship is driven by an unmeasured third variable. For this reason, longitudinal research will be necessary to establish the causal relationship that is suggested by the current results. Second, the findings of these studies rely on self-reported gambling problems, and factors such as impression management, self-deception, or memory loss might cloud the relationship between actual problem gambling and self-reported gambling problems. For this reason, future studies should assess behavioral indicators of gambling problems. For example, perseverance in gambling tasks has been shown to be higher among pathological gamblers than among normal adults (Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2005). If older adults who gamble rely on executive control to prevent themselves from gambling excessively, those with poor executive functioning should have more difficulty stopping gambling than those with good executive functioning.
It should also be noted that these results do not suggest that older gamblers have more problems with executive functioning than older non-gamblers, nor do they suggest that executive functioning deficits lead all older adults to experience gambling problems. Rather, they provide initial evidence that declines in executive control might cause older adults who already gamble to develop gambling problems. This evidence can only be taken as tentative at this point in time, as longitudinal data are necessary to establish a causal role for executive decline.

Finally, it is worth mentioning that the current research relied on only a single measure of executive functioning, which is primarily an indicator of set switching and perseveration. There are a variety of executive functions, however, and a wide assortment of tasks designed to measure them. Although the Trail Making Test is well studied and easy to administer in gambling establishments, it would be highly beneficial to broaden the scope of measurement of executive dysfunction. From the current studies it is unclear whether there is something special about the set switching and perseveration aspects of the Trail Making Test that predict gambling problems among older adults, or whether other aspects of executive control might also predict gambling problems. For example, it seems possible that measures of executive functioning that tap behavioral restraint or inhibition (see Lustig, Hasher, & Zacks, 2007; Yoon, May, & Hasher, 2000) might also predict gambling problems among older adults, as gambling problems themselves reflect a lack of restraint. This is a question for future research, as the current results clearly represent only a first step in the examination of the relationship between age, executive functioning, and gambling problems.

CONCLUSIONS

A growing literature suggests that executive decline brought about by frontal lobe atrophy leads to a variety of social and cognitive consequences (see Lustig et al., 2007; von Hippel, 2007; West, 1996). The current studies extend this prior work by demonstrating that executive decline is associated with gambling problems among older adults who gamble. These results raise the possibility that increased gambling among older adults might not always be an issue of personal choice, as some older adults might have difficulty engaging in self-control when gambling due to losses in executive functioning. Future research should attempt to corroborate these findings longitudinally. If the causal relationship suggested by the current findings is supported in longitudinal research, such findings would have important public policy implications, and indeed some protections for older adult gamblers might be appropriate. Such a pattern of findings would also suggest new avenues of treatment of gambling problems based on factors known to improve
executive functioning among older adults, such as aerobic exercise (Kramer et al., 1999) and circadian rhythms (Hasher et al., 1999).

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