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Risk-Taking Behavior Differs Between Older Adults with and without Mild Cognitive Impairment

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Abstract.
Background: Adequately evaluating risk and making decisions is vital but understudied for older adults living independently but with compromised cognition, as seen in those with mild cognitive impairment (MCI), specifically those with amnestic MCI (aMCI) which is associated with higher risk of conversion to Alzheimer's disease.
Objective: We propose to comprehensively evaluate risk-taking behaviors across domains important for everyday activities between an aMCI group and their cognitively healthy counterparts (HC).
Methods: A case-control study design. Data on risk-taking behaviors via the Domain-Specific Risk-Taking Scale (DOSPERT), and candidate confounding mental health factors (i.e., neurodegeneration, depression, and fatigue) were collected. Analyses on group difference and interaction between group and confounding factors on risk-taking behaviors were conducted.
Results: The aMCI group showed a higher likelihood of risk-taking than HC ($t = 4.38$, df = 73, $p < 0.001$). Moderation analysis showed fatigue ($F = 5.91$, $p = 0.018$) and presence of depression ($F = 4.52$, $p = 0.037$), but not neurodegeneration, as significant moderators for group and DOSPERT total score, controlling for sex. In post-hoc analyses, there was a significant relationship between both fatigue ($B = –7.83$, SE = 3.65, $t = –2.14$, $p = 0.036$), and presence of depression ($B = –20.80$, SE = 9.97, $t = –2.09$, $p = 0.041$), with DOSPERT total score for HC but not for aMCI. There were no significant relationships between neurodegeneration, fatigue, or depression with any specific risk-taking domains after correction for multiple comparisons.
Conclusions: Our results show differences in risk-taking behavior between older adults with and without intact cognition, and overall decision-making is affected by fatigue and depression in HC but not aMCI, together suggesting the importance of cognition in the ability to adjust risk-taking behaviors.

Keywords: Alzheimer's disease, decision making, functional status, mild cognitive impairment, risk-taking

INTRODUCTION

Older adults living independently have to make complex decisions with varying risks and rewards in both the short- (day-to-day) and long-term (planning for the future) related to finances, healthcare, social engagements, and household maintenance.[1] Failure to successfully evaluate complex options, outcomes, and risks associated with decisions can have a negative impact on older adults' lives.[2] Therefore, factors influencing older adults' risky decision-making behavior, especially in real-world scenarios are important to understand. Here, we will define 'risky decisions' as decisions with an uncertain outcome and the *possibility* to negatively impact the decision-maker. Compared to their younger peers, cognitively healthy older adults are relatively risk-adverse[3,4] (e.g., they invest more conservatively, are less likely to be smokers, are more likely to wear

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a seatbelt, etc.[5]), although empirical findings are mixed,[6,7] and risk aversion may negatively influence decision-making ability (that is, some risks are necessary for long-term personal advantages).[8] As risky decisions can have both negative and positive outcomes (for older adults this may be investing more aggressively, deciding between treatment plans for a health condition, etc.), navigating these decisions requires high level cognitive processes. Decision-making has been studied across the spectrum of cognitive decline, with dementia patients having the worst decision-making skills.[9,10] There is evidence that older adults with cognitive impairment are more likely to take risks than their cognitively healthy counterparts,[11] perhaps due to their cognitive decline. However, research on individuals with advanced cognitive decline, who likely have already lost much of their independence and may not be legally responsible for their own healthcare, legal, or financial decisions,[12] may not provide useful insight into key factors affecting one's level of success in living independently. To understand this, real-world context of individuals who live independently but may experience mild cognitive changes is needed. Individuals with mild cognitive impairment (MCI), showing selective cognitive impairment but often functioning independently, are a group with a great vulnerability to altered risk-taking behaviors.[13] In the decision-making literature there have been key differences shown between HC, MCI, and dementia samples in their ability to make decisions in an advantageous way, with cognitive deficits generally leading to worse decision-making.[9,14,15]

However, there are two potential gaps in literature regarding risk-taking behaviors during cognitive impairment and dementia. First, studies evaluating risk-taking in typical aging and in cognitively impaired individuals have been dominated by studying financial decision-making (see review by Sun et al.[16]). Risk-taking behaviors can differ substantially across contexts (e.g., executives taking financial risks in their professional but not personal lives, or individuals taking risks in laboratory experiments not in the real world[17]) or domains (e.g., smokers uniquely take risks associated with health[18]). Among individuals with MCI, individual risk-taking domains may be affected disproportionally given the afflicted cognitive domains.[19–21] MCI affects one or more cognitive domains including executive function, learning and memory, and complex attention[22] which are all important for decision-making. Focusing primarily on financial risk-taking behavior therefore is not a reliable method of categorizing participants as risk-taking or risk-averse across different risk-taking domains or real-world scenarios.[23] Second, aging-related confounding factors are understudied; that is, it is unclear whether the often-observed difference in decision-making between older adults with and without cognitive impairment are due to the neuropathological changes of cognitive impairment or aging overall. It is known that as an individual ages there are various "byproducts" related to decision-making as well as cognitive impairment. Thus far, among the most common confounding factors are affect-motivation oriented (see review by Sun et al.[16]). For example, fatigue and depression are two common symptoms in old age, and are well-known to relate to cognitive impairment (including differentiating individuals with MCI from HC)[24,25] and impaired decision-making.[25–27]

To address the gaps mentioned above we ask two key research questions. First, we aimed to compare risk-taking behaviors of older adults with amnestic MCI (aMCI) to cognitively healthy controls (HC) across real-world decision-making scenarios. aMCI is characterized by deficits specifically in memory and is associated with higher risk of conversion to Alzheimer's disease (AD), whereas non-amnestic MCI is characterized by deficits in other cognitive domains and is associated with higher risk of conversion to other forms of dementia.[28] We utilized the short form Domain-Specific Risk-Taking Scale (DOSPERT), a validated self-report questionnaire that assesses the likelihood of adults engaging in real-world risky behaviors across social, financial, health and safety, recreational, and ethical scenarios[29] to evaluate participants' risk-taking behaviors. Second, we examined whether any aging-related confounding factors would influence the relationship between cognitive impairment and risk-taking behaviors. We focused on depression and fatigue; and as a comparison, we also considered a third confounding factor—the severity of AD-related neurodegeneration since cognitive impairment and dementia related pathophysiology, despite interrelated, independently contribute to a diagnosis of dementia.[30] Overall, we hypothesized that older adults with aMCI would engage in more risk-taking behavior than HC. However, we cannot exclude the possibility that the relationship between cognitive impairment and risk-taking behavior is due to aging-related confounding factors; if this is true, fatigue and depression would

Table 1
Sample characteristics

	HC ($n = 35$)		MCI ($n = 40$)		t(df) or χ^2 test (p)
	Mean	SD	Mean	SD	
Background characteristics					
Age (y)	71.62	4.77	71.70	7.00	t(69) = –0.06 ($p = 0.48$)
Education (y)	16.77	2.49	15.96	2.95	t(73) = 1.27 ($p = –0.21$)
Sex (n of men, %)	9 (25.7%)		16 (40.0%)		$\chi^2(1) = 1.71$ ($p = 0.19$)
Race/Ethnicity (% non-Hispanic white)	31 (88.6%)		38 (95.0%)		$\chi^2(1) = 1.05$ ($p = 0.31$)
MoCA Score	27.63	1.72	23.33	2.57	t(69) = 8.63 ($p < 0.001$)
RAVLT delayed recall score	10.89	2.64	5.28	2.65	t(73) = 9.16 ($p < 0.001$)
Candidate confounding mental health factors					
ADSCT	2.89	0.13	2.77	0.14	t(72)* = 3.77 ($p < 0.001$)
Presence of depression (n, %)	3 (8.6%)		15 (37.5%)		$\chi^2(1, 75) = 8.56$ ($p = 0.003$)
MFI	2.32	0.77	2.61	0.81	t(73) = –1.62 ($p = 0.055$)
DOSPERT likelihood scores					
Total score	66.29	15.60	83.35	17.82	t(73) = –4.38 ($p < 0.001$)
Ethical domain	8.29	2.74	9.30	3.41	t(73) = –1.41 ($p = 0.082$)
Financial domain	11.53	3.48	15.25	5.99	t(64) = –3.32 ($p < 0.001$)
Health and safety domain	9.00	3.77	12.95	5.84	t(67) = –3.52 ($p < 0.001$)
Recreational domain	9.54	5.16	16.43	8.33	t(66) = –4.36 ($p < 0.001$)
Social domain	28.26	7.46	29.43	7.26	t(73) = –0.69 ($p = 0.25$)

For presence of depression, we used different versions of Geriatric Depression Scale (GDS) in HC (GDS-15) and MCI (GDS-30). Presence of depressive symptoms were defined as GDS-15 total score > 5 or GDS-30 total score >10. MoCA, Montreal Cognitive Assessment; RAVLT, Rey's Auditory Verbal Learning Test; ADSCT, Alzheimer's disease-signature cortical thickness; *one HC participant's ADSCT was excluded due to the failure of quality control; MFI, Multidimensional Fatigue Inventory. FDR correction was applied to group comparison for DOSPERT domains.

influence risk-taking in both groups; if this is not true, fatigue and depression would only relate to risk-taking in the HC group.

METHODS

Study design and participants

A case-control study design was applied to data obtained from two previously reported studies. The HC sample was obtained from a cross-sectional observational study on fatigue (see previous report[31]). The aMCI sample was obtained from the baseline assessment of a Stage 0 double-blinded randomized control trial study on mood symptoms (see primary report[32]). Participants in both samples completed neuropsychological testing, questionnaires, and imaging in a lab-based setting at University of Rochester Medical Center in Rochester, NY. Both studies were approved by the University's Institutional Human Subject Review Board. All participants gave written informed consent.

Participants were included in the aMCI group based on a NIA-AA guided MCI diagnosis,[33] operationalized as having a Montreal Cognitive Assessment (MoCA) education-adjusted score of $18 \leq x \leq 26$ (MoCA is shown to have high sensitivity and specificity for detecting MCI[34]), scoring one standard deviation below age and education corrected norms on Rey's Auditory Verbal Learning Test (RAVLT) delayed recall,[33] scoring ≤ 30 on the Activities of Daily Living Prevention Instrument (self-reported), and absence of dementia diagnosis. HC participants scored above 26 on the MoCA and recalled ≥ 6 words in delayed recall in the RAVLT (see Table 1). All participants across both samples were aged 60+, living independently, and were free of medical history of dementia or major neurologic disorders during their enrollment to respective studies.

Measurement

DOSPERT

The DOSPERT scale, originally developed as a 40-item scale for use in English-speaking young adult populations and later revised to a 30-item scale for use in a wider range of age ranges, languages, and education levels, is divided into 5 domains: ethical, financial, health & safety, recreation, and social risk-taking.[29] Each subscale, or domain, consisted of 6 items. The DOSPERT has two separate response scales, one asks about one's likelihood to engage in a particular risky activity and the other asks about how risky the respondent perceives the activity to be.

In healthy younger adults, activities they perceive to be riskier are those that they are less likely to engage in.[29] Of note, across our two samples, we only consistently collected the response scale that reflects "risk-taking likelihood". The HC sample also reported their "risk perception" which was minimally correlated with the "risk-taking likelihood" scale ($r = –0.033$, df = 35, $p = 0.85$). Participants rated their likelihood to engage in each risky action described by each scale item from 1 (being the least likely) to 7 (being the most likely). Domain scores were calculated by summing the response scores of each of the 6 items in each domain. Total DOSPERT score was calculated by summing all 30 scale items with higher scores indicating higher likelihood of engaging in certain behaviors.

Internal consistency and discriminant validity of the DOSPERT

Given limited research using the DOSPERT, particularly in older adults and those at-risk for dementia, we assessed internal consistency of the total scale and domains, as well as discriminant validity of the domains in both the whole sample and both subgroups. Cronbach's alpha for the total scale was acceptable in both the whole sample and in each group (total sample = 0.77, MCI = 0.75, HC = 0.68). Cronbach's alpha for DOSPERT domains in the both the total sample and each group separately ranged from unacceptable (for the ethical domain) to acceptable (for others). There were also significant correlations across multiple domains, particularly between ethical and other domains (Supplementary Table 1). This suggests that in our sample the DOSPERT domains had varying levels of internal consistency and discriminant validity and is in line with previous research showing that while risk-taking behavior is correlated across some domains there is also a large amount of variance unique to specific domains suggesting domain-specific behaviors.[35] In this paper, we consider total score as the primary measure and evaluated relationships with DOSPERT domains as post-hoc follow-up analyses. Analyses of DOSPERT domains should be interpreted accounting for their varying internal consistency scores and results related to ethical risk-taking should be interpreted with caution. The fact that these measures of internal consistency were similar across MCI and HC groups provides confidence for the use of this scale in individuals at-risk for dementia.

Candidate confounding mental health factors

We include the following variables.

Neurodegeneration: Neurodegeneration was measured as AD-signature cortical thickness (ADSCT), an empirically established index of atrophy in regions vulnerable to early AD-related neurodegeneration. ADSCT was calculated as the mean cortical thickness of four bilateral regions: entorhinal cortex, middle and inferior temporal gyri, and fusiform gyrus.[36] Cortical thickness was extracted from Freesurfer output of processed T1 structural data that was parcellated with the Desikan-Killiany-Tourville atlas.[37] Lower scores in ADSCT indicate worse neurodegeneration.

Depression: Depression was measured using the Geriatric Depression Scale (GDS).[38,39] HC and aMCI participants were administered different versions of the GDS: In the study HC participants were enrolled the 15-item GDS was used. In the study including aMCI patients the 30-item GDS was used. Sum of all positive depressive symptoms were calculated. Sum score > 5 on the GDS-15, or > 10 on the GDS-30 was considered as presence of depression.

Fatigue: Fatigue was measured with the 20-item Multidimensional Fatigue Inventory (MFI).[40] Participants rate their level of agreement with statements regarding their physical and mental fatigue on a 5-point scale, ranging from 1 (very true) to 5 (not at all true). Positively phrased items are reverse-scored, and all items were averaged; the maximum score is 5 with higher scores indicating a higher level of fatigue.

Analysis

We assessed the internal consistency of DOSPERT items for both the total scale and domains using Cronbach's alpha in the whole sample and in both groups separately. We also tested the discriminant validity of the DOSPERT domains using cross-correlations in the whole sample and in both groups separately.

Group differences in background characteristics, DOSPERT, and candidate confounding mental health factors were compared using independent *t*-tests for continuous variables and χ^2 test for dichotomous variables. Levene's test for equivalence of variance was performed for all independent *t*-tests: for any that did not meet the assumption of equal variance, test statistics were adjusted using a Satterthwaite approximation to adjust the degrees of freedom, using the default option in SPSS. Corrected degrees of freedom are reported in Table 1 for these variables:

age, MoCA, and the DOSPERT financial, health and safety, and recreational domains.

When examining relationships between DOSPERT and candidate confounding mental health factors, Pearson's r correlation was used when the confounding factor was continuous, or independent *t*-test with variance equivalence pre-evaluated when the confounding factor was dichotomous. As sensitivity analyses based on the available sample sizes, assuming the alpha at 0.05 and power at 0.80, we would be able to detect the effect size at $d = 0.65$ (moderate effect).

Moderation analyses were performed to examine whether any confounding mental health factors would moderate the relationship between group and DOSPERT. We controlled for sex due to the evident group difference and relevant literature.[41,42] Moderation analysis was performed using the generalized linear model on $y = a+b+axb$ (where y refers to DOSPERT, a as a founding factor, and b as group). As sensitivity analyses based on the available sample sizes, assuming the alpha at 0.05, power at 0.80, number of predictors at 3, we would be able to detect at $R^2 = 0.10$ (small effect).

Of note, for primary analyses with DOSPERT total score, *p* value was set at 0.05. Multiple comparisons were addressed with False Discovery Rate (FDR) across DOSPERT domains.

RESULTS

Group comparison of DOSPERT total and domain scores

Based on the DOSPERT total score, aMCI participants showed a higher likelihood of risk-taking than HC ($t = 4.38$, df = 73, $p < 0.001$). aMCI participants showed a higher domain-specific likelihood of risk-taking in finance, health and safety, and recreation (see Table 1).

Candidate confounding mental health factors and their relationships with DOSPERT.

aMCI participants had significantly worse neurodegeneration and more depression cases than HC. aMCI participants also had worse, but statistically nonsignificant, fatigue scores than HC (see Table 1). The DOSPERT total score was not related to neurodegeneration, depression, or fatigue when the two groups were combined (Supplementary Table 2).

Moderation analysis showed no moderating effect of neurodegeneration and group on DOSPERT total score ($F = 1.06$, $p = 0.31$), adjusted for sex. There were significant moderating effects of fatigue (Wald's $\chi^2 = 6.33$, $p = 0.012$), as well as presence of depression (Wald's $\chi^2 = 4.85$, $p = 0.028$) for explaining the relationship between group and DOSPERT total score, adjusting for sex. In post-hoc analyses, there was a significant relationship between both fatigue ($B = -7.83$, SE = 3.65, $t = -2.14$, $p = 0.036$), and presence of depression ($B = -20.80$, SE = 9.97, $t = -2.09$, $p = 0.041$), with DOSPERT total score for HC but not for aMCI, suggesting *less* fatigue or depression explain why some HC participants would *more* likely engage in risk-taking behaviors than others in HC group; whereas fatigue or depression did not affect the risk-taking behaviors in aMCI group (see Fig. 1). When looking into DOSPERT domains in relation to fatigue or depression, no significant domain results remained after FDR correction (Supplementary Table 3).

Of note, we also analyzed the associations between DOSPERT risk perception total score and the three confounding factors in the HC group alone (note: we did not collect the risk perception subscale in the aMCI sample). There was no association (p ranged 0.59 to 0.87). When controlling the DOSPERT risk perception total score, the significant relationships between fatigue ($B = -7.85$, SE = 3.31, $t = -2.37$, $p = 0.024$) and presence of depression ($B = -20.89$, SE = 9.02, $t = -2.32$, $p = 0.027$) and DOSPERT risk-taking total score remained similar.

DISCUSSION

We compared risk-taking behavior of older adults with and without aMCI in real-world decision-making scenarios. We also examined whether factors (i.e., fatigue, and depression) related to mental health that worsen in MCI would explain individual differences in risk-taking behavior. We found older adults with aMCI are more likely to take risks overall compared to HC, and they are specifically more likely to take risks in the financial, health and safety, and recreation domains. Mental health factors overall did not relate to DOSPERT total sore. However, fatigue and depression moderated the relationship between group and DOSPERT total score. Interestingly, less fatigue and depression seem to explain why some healthy older adults would be *more* willing to engage in risk-taking behaviors than others, but does not explain any

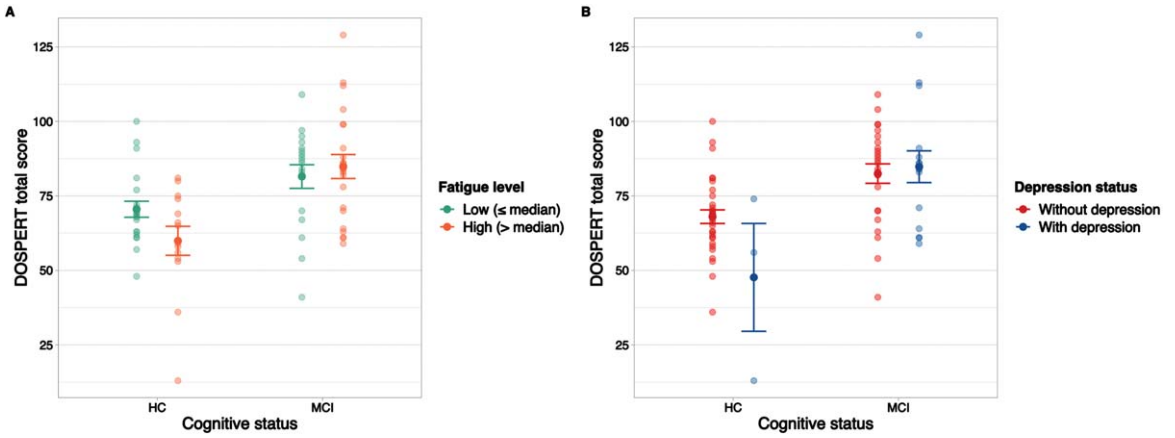

Fig. 1. Significant moderators (A. Fatigue; B. Depression) for the relationship between cognitive status and DOSPERT total score. Of note, the cutoff for fatigue level here is for display purpose only. (The y-axis represents mean+/- 1 standard deviation).

individual difference in risk-taking behaviors in the aMCI group.

Our findings indicate that older adults with aMCI engage in more real-world risk-taking behavior compared to HC. Analysis of differences in specific risk-taking domains showed that this finding was driven by increases in risk-taking behavior specifically in recreational, financial, and health and safety domains but not in ethical or social domains. Activities relating to finances and health and safety are highly relevant for older adults, and their ability to make appropriate decisions in these areas plays a critical role in maintaining independence. Social and ethical risk-taking behavior may be more stable and resistant to change due to engrained social behaviors and moral structures, which people generally abide by in adulthood.[43]

The moderation analysis revealed some interesting, even counterintuitive findings. First, while more severe fatigue and depression explained why some HC individuals would less likely engage in risk-taking behaviors; such relationships did not apply to aMCI group. It is possible that cognitively healthy older adults may regulate their decision-making behaviors according to their emotion and energy status. The ability to regulate behavior in line with one's internal state is a critical aspect of successful behavioral flexibility that relies on prefrontal cortex regions that can integrate internal and external signals when making decisions.[44] These regions are affected by pathology in HC to AD progression that may interfere with this type of behavioral flexibility and explain the lack of moderation in aMCI.[45,46] Differences in prefrontal cortex functioning and connectivity between MCI and HC participants has been further supported by fMRI studies.[47,48] While this behavior may seem adaptive in this case (protecting risk-taking from changes during periods of fatigue and depression in MCI), it may suggest a more general deficit in aMCI that is important to consider for more adaptive forms of behavioral flexibility. This finding also suggests that depression and fatigue are moderators of risk-taking behavior in healthy older adults and intervention may be necessary to ensure even healthy older adults do not take untoward risks depending on these states. Previous research has supported the idea that late-life depression results in executive dysfunction and that this leads to altered decision-making,[10,49] and that fatigue is related to poor working memory performance in older adults.[50] Mental fatigue is also primarily associated with the frontal and occipital lobes of the brain and mentally fatigued individuals tend to have decreased executive function (see review by Kunasegaran et al.[51]) which we have established is a key cognitive substrate of decision-making. The findings from these studies support our conclusions that depression and fatigue are key factors influencing risky decision-making in older adults.

In our study, AD-related neurodegeneration was not a significant moderator. Combining the findings above concerning the group difference in DOSPERT score, these findings suggest that degree of neurodegeneration does not explain additional variance in individual differences in risk-taking beyond the difference in clinical/cognitive status between aMCI and HC.

It is important to acknowledge key limitations in this research. First, we focused only on risk-taking

likelihood, and did not measure risk perception differences between the two groups as we did not have perception data for the aMCI sample. We do know, however, that in the HC group there was minimal association between risk perception and risk-taking likelihood which is different from what previous research shows in younger adults.[52] There were also minimal associations between risk perception and confounding mental health factors. In the future it will be important to measure these associations in MCI participants to understand all potential influences on their decision-making. Relevantly, it is unclear whether individuals' awareness of absolute risk would influence their risk-taking behaviors. This is a particular concern for older adults living with MCI since impaired awareness or anosognosia is a common phenomenon as we have previously reported on.[53] A recent study using data from the Rush Memory and Aging Project also found that metamemory (or one's self awareness of their memory function) was an indicator of impaired financial decision-making.[54]

Another key limitation in this research is regarding AD pathology. We only had the ADSCT score available for our samples. While this is a validated measure of AD-related neurodegeneration, we acknowledge that in our sample there is likely also variability in neurodegeneration in regions other than those captured by ADSCT related to both typical aging and differences in AD pathology. This neurodegeneration is difficult to capture in a single score but may be reflected in novel measures such as brain age. Given the limited scope and sample in this paper we chose to focus on the most well-validated measure of AD-related neurodegeneration but future work should examine neurodegeneration more broadly, in addition to considering other aspects of AD pathology: e.g., whether amyloid-beta or tau would be more sensitive markers of risk-taking behaviors in older adults with MCI. Relevantly, we were not able to further phenotype aMCI to single versus multiple-domain. However, those with aMCI beyond memory deficits (multiple-domain aMCI) may have higher chance to have abnormal risk-taking behaviors due to their potential deficits in executive function.

Lastly, in future research characterizing differences in real-world decision-making between MCI and HC groups it will be important to consider additional individual characteristics that may influence within-group differences in risky decision-making. In some previous research, which has primarily used gambling tasks to assess risk-taking, individuals were stratified according to 'decision-making profiles'.[10] Employing this method in future studies of risky decision-making in HC and MCI samples will allow researchers to understand the potentially separate trajectory of change in each decision-making profile concurrent with cognitive decline. Individual differences in personality may also affect decision-making differences within groups, for example one study found that high agreeableness was related to increased risky decision-making, and in another personality disturbances were correlated with poor decision-making.[55,56] It is important to consider personality in future research evaluating risky decision-making in MCI as some research has shown personality changes in MCI and AD patients.[57–59]

Overall, understanding the differences in risk-taking behaviors between older adults with and without MCI is an important factor for addressing functional independence and safety in aging. We found that risk-taking in domains specifically related to important life decisions and activities (i.e., financial, health and safety, and recreational) is significantly impaired in those with aMCI. There is therefore a need to address how appropriate decision-making can be promoted throughout the process of cognitive decline. Addressing methods and tools for older adults to properly evaluate risk may be an important step in helping them prolong their functional independence. For example, shared decision-making, a practice in which patients and clinicians work together to evaluate medical outcomes along with patients' values, has been proposed as a key method to work with MCI patients to make healthcare decisions that align with their values and preferences, as well as to help inform future decisions.[60] Further development in guided decision-making practices will be an important step in mitigating overall risky behavior in MCI patients, especially in the case where their cognitive decline may worsen.

AUTHOR CONTRIBUTIONS

Sarah Therrien (Data curation; Formal analysis; Visualization; Writing – original draft; Writing – review & editing); Mia Anthony (Data curation; Visualization; Writing – review & editing); Adam Turnbull (Writing – review & editing); F. Vankee Lin (Conceptualization; Funding acquisition; Resources; Supervision; Writing – review & editing).

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CONFLICT OF INTEREST

Adam Turnbull is an Editorial Board Member of this journal but was not involved in the peer-review process nor had access to any information regarding its peer-review. The authors have no other conflicts of interest to report.

DATA AVAILABILITY

The data used in this study is available at https://github.com/adamgeorgeturnbull/DOSPERT_aging.

SUPPLEMENTARY MATERIAL

The supplementary material is available in the electronic version of this article: https://dx.doi.org/10.3233/JAD-231448.

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