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ALCOHOLISM CLINICAL & EXPERIMENTAL RESEARCH

META-ANALYSIS

Systematic review and meta-analysis on the association between theory of mind and alcohol problems in non-clinical samples

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Abstract

Background: Deficits in theory of mind (ToM) found in individuals with alcohol use disorder (AUD) are often thought to result from prolonged heavy alcohol use. However, links between deficits in ToM and greater alcohol problems are often also present in non-clinical samples (e.g., adolescents and young adults) who may not have a similar long-lasting history of alcohol consumption as individuals with AUD. The current study is the first to systematically review and meta-analyze results from studies examining associations between lower ToM and greater alcohol problems in non-clinical samples. Evidence of reliable associations in these non-clinical samples would support the idea that deficits in ToM might also precede the emergence of AUD.

Methods: PsycINFO, PubMed, and Google Scholar were searched according to our preregistered International Prospective Register of Systematic Reviews (PROSPERO) protocol (CRD42021225392) and following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology. We systematically reviewed sample characteristics and ToM measures in identified articles. We then meta-analyzed the findings of association between ToM and alcohol problems in non-clinical samples using random effects models.

Results: Nearly all studies used a measure of ToM that assessed the ability to infer the mental states of others based on eye region cues. Meta-analytic results demonstrated that lower ToM was associated with more alcohol problems ($r = -0.16$, $k = 6$, CI = [−0.26, −0.04], $p < 0.01$, $Q = 15.55$, $I^2 = 67.85$), and there was significant heterogeneity across studies. Gender ($\beta = 0.0003$, CI = [−0.006, 0.007], $z = 0.09$, $p = 0.93$), age ($\beta = -0.008$, CI = [−0.03, 0.01], $z = -0.82$, $p = 0.42$), and study quality ($\beta = -0.10$, CI = [−0.35, 0.15], $z = -0.82$, $p = 0.41$) did not explain the heterogeneity.

Conclusion: In non-clinical samples, lower ToM is associated with more alcohol problems, indicative of a small effect size. Future longitudinal studies are needed to explore whether socio-cognitive deficits may also serve as a risk factor for alcohol misuse.

ALCOHOLISM CLINICAL & EXPERIMENTAL RESEARCH

KEYWORDS
adolescents, alcohol problems, alcohol use, empathy, socio-cognitive deficits, theory of mind, young adults

INTRODUCTION

Alcohol is one of the most commonly consumed addictive substances in the world (Ritchie & Roser, 2018; SAMHSA, 2021). Excessive alcohol consumption can lead to negative physical, psychological, and social outcomes (Bohm et al., 2021). Approximately 10.1–15% of the United States population, and around 8.6% of men and 1.7% of women globally, develop an alcohol use disorder (AUD), which is linked to significant morbidity and mortality and has detrimental consequences for overall physical, social, and mental health (Rehm & Shield, 2019; SAMHSA, 2021). Social impairments are a key feature of AUD (APA, 2013), but little is known about the social and cognitive mechanisms that may contribute to these impairments (Massey et al., 2018). A better understanding of these underlying mechanisms can aid in the development of more effective and targeted AUD interventions.

Some of the social impairments present in AUD may stem from deficits in theory of mind (ToM), a facet of social cognition typically defined as the capacity to understand other people by ascribing mental states (e.g., thoughts, intentions, desires, beliefs) to them (Apperly & Butterfill, 2009; Frith & Frith, 2005). ToM helps individuals explain and predict others' behavior and is thought to be a vital skill for successful social interactions (Gunther Moor et al., 2012). ToM has been conceptualized as being multidimensional, including a decoding or affective facet (typically assessed by tasks that require individuals to decode others' mental states based on information that can be observed, such as facial expressions; e.g., Lyvers et al., 2018) and a reasoning or cognitive facet (typically assessed by tasks that require individuals to infer others' beliefs and intentions based on vignettes; e.g., Amenta et al., 2013). Notably, two prior meta-analyses demonstrated that individuals with AUD, compared to healthy controls, showed impairments in ToM assessed using a range of measurement techniques (e.g., questionnaires, semi-structured interviews, behavioral tasks) (Bora & Zorlu, 2016; Onuoha et al., 2016). Specifically, across 12 studies, Bora and Zorlu (2016) found that individuals with AUD (n = 317) showed impairments in both the decoding (i.e., affective) and reasoning (i.e., cognitive) facets of ToM compared to healthy controls (n = 298), with moderate effect sizes (but see Maurage et al., 2016 showing a specific deficit in affective [vs. cognitive] ToM in individuals with alcohol dependence compared to healthy controls). Similarly, across 8 studies (7 of which were included in Bora & Zorlu, 2016), Onuoha et al. (2016) found that compared to healthy controls (n = 187), individuals with AUD (n = 187) showed deficits in ToM,[1] indicative of a large effect size.[2] Overall, these two meta-analyses demonstrate that individuals with AUD show reliable deficits in ToM compared to healthy controls.

Chronic heavy alcohol consumption is thought to lead to deficits in ToM in individuals with AUD, as it has been shown to result in abnormalities and reduced cortical thickness in brain regions linked to socio-cognitive and emotional processing (e.g., prefrontal and limbic areas; Durazzo et al., 2008; Oscar-Berman et al., 2014; Rupp et al., 2006; Schmidt et al., 2017; Volkow et al., 2011). However, several studies have found ToM deficits in individuals with problematic alcohol use more generally, including in adolescent and young adult samples, who may not have the same history of long-term alcohol misuse and problems as those with AUD (e.g., Laghi et al., 2019; Lannoy et al., 2020). In fact, some have proposed that socio-cognitive deficits (including ToM deficits and deficits in related constructs, such as empathy) may predispose individuals to develop alcohol problems and act as an early risk factor for AUD (Kumar et al., 2022; Winters et al., 2021). Several mechanisms have been proposed for the link between socio-cognitive deficits and alcohol problems. Individuals with deficits in socio-cognitive abilities may be insensitive to social cues to stop drinking (Massey et al., 2018), may rely on alcohol as a coping mechanism in social situations (Kuntsche et al., 2005; Lyvers et al., 2019), may prefer substance use over making social connections (Winters et al., 2021), may over-value peers' attitudes/norms about drinking, and may drink to fit in with what they perceive as normative behavior (Cousijn et al., 2018; Laghi et al., 2019). Alternatively, individuals with socio-cognitive deficits who may struggle with social interactions while sober may benefit from alcohol's socially facilitative effects. Indeed, acute alcohol consumption has been shown to increase socio-cognitive abilities (e.g., empathy), sociability, social bonding, and other prosocial variables (Creswell et al., 2012; Dolder et al., 2017; Kirkpatrick & de Wit, 2013; Sayette et al., 2012). Thus, individuals with lower socio-cognitive abilities might be at a greater risk to increase their drinking and develop alcohol problems due to their increased sensitivity to alcohol's socially rewarding effects (Kumar et al., 2022). Taken together, researchers have hypothesized that socio-cognitive deficits, including impairments in ToM, may be an early risk factor for the development of alcohol problems, in addition to chronic heavy alcohol use resulting in such deficits.

Importantly, though, to our knowledge there are no longitudinal studies that have prospectively examined the association between early ToM deficits and subsequent alcohol problems. However, several cross-sectional studies using non-clinical (i.e., adolescent, young adult/college, and adult) samples show links between lower ToM and more alcohol problems, which supports the idea that these deficits may have existed before the onset of AUD. For instance, lower decoding ToM as assessed by the Reading the Mind in the Eyes Task (RMET; Baron-Cohen et al., 2001), which measures the ability to infer emotional states of others from eye region photographs, was associated with greater past year alcohol problems on the Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993) in an adult community sample (Lyvers et al., 2018). Likewise, lower

decoding (i.e., affective) ToM as assessed by Yoni's task (which also measures the ability to infer mental states of others based on eye gaze cues; Shamay-Tsoory & Aharon-Peretz, 2007) was associated with greater past 6-month binge drinking, a pattern of problematic alcohol consumption, in an adolescent sample (Lannoy et al., 2020). Finally, two recent reviews found support for socio-cognitive deficits in non-clinical samples. First, Winters et al. (2021) examined associations between socio-cognitive deficits (e.g., callous-unemotional traits, empathy, ToM) with both concurrent and future adolescent substance use and generally found support for these associations (Winters et al., 2021). However, only one cross-sectional study on the association between ToM and alcohol use was included (Lannoy et al., 2020), so a meta-analysis was not conducted, and the review did not include studies on young adults and adults. Second, we found reliable links between lower empathy and heavier alcohol consumption and more alcohol problems in non-clinical samples in a recent meta-analysis (Kumar et al., 2022), but we did not examine ToM deficits. Thus, much prior research suggests that deficits in ToM may be linked to alcohol problems in non-clinical samples, but no prior studies have meta-analyzed results across studies. Documenting a reliable association between ToM deficits and alcohol problems in non-clinical samples may motivate longitudinal studies to clarify the direction of this association.

The aim of the current study is to provide a systematic review and quantitative analysis on the association between ToM and alcohol problems in non-clinical samples. Specifically, we first provide a context for understanding the role of ToM in problematic drinking in non-clinical samples by systematically reviewing sample characteristics and ToM measures. We then provide a meta-analysis of associations between deficits in ToM and alcohol problems in non-clinical samples. When possible, relevant moderating variables were examined, such as study quality, age, and gender.[3] We hypothesized that lower ToM would be associated with more alcohol problems, providing evidence that links between deficits in ToM and AUD extend to non-clinical samples, which supports the proposition that deficits in ToM may be a risk factor for the development of alcohol problems (e.g., Kumar et al., 2022; Winters et al., 2021).[4]

METHOD

We followed Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA; Moher et al., 2009) guidelines (see Figure 1) and a preregistered International Prospective Register of Systematic Reviews (PROSPERO) protocol (http://www.crd.york.ac.uk/PROSPERO/, registration number CRD42021225392). A literature search was conducted to collect relevant studies published between January 1970 and April 2022 using the databases PubMed, PsycINFO, and Google Scholar. Search terms included [theory of mind] and [alcohol] (see Figures S3–S5). We limited searches for two databases; keywords had

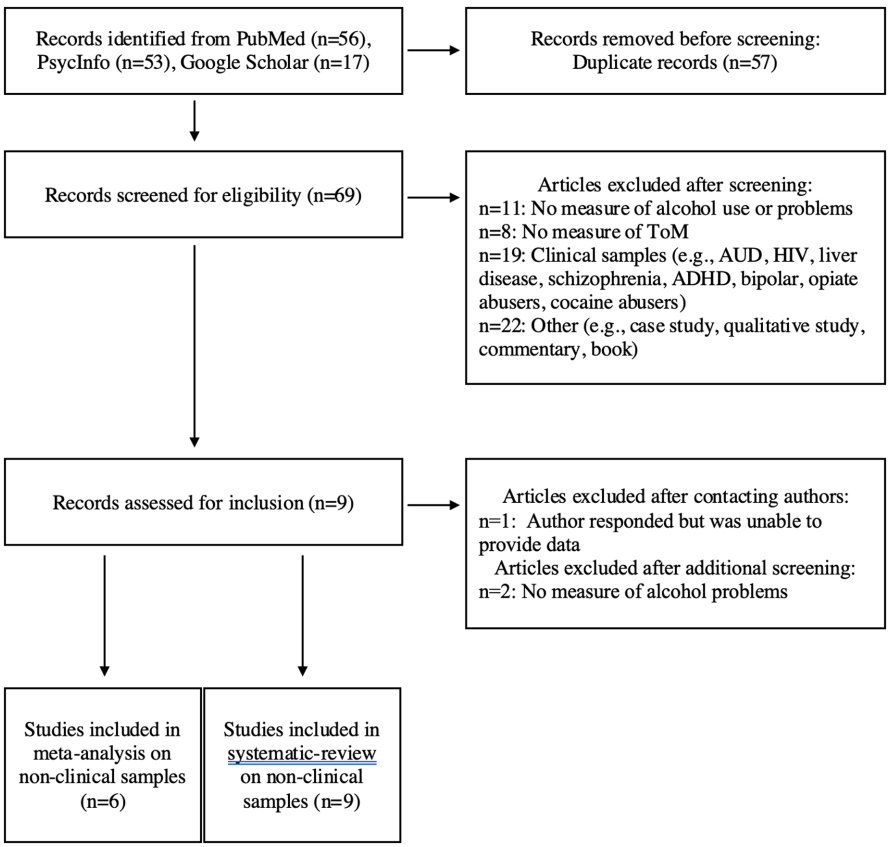

FIGURE 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram for papers selected for the systematic review and meta-analysis

to appear in the title for Google Scholar and in the title or abstract for PsycINFO. We also scanned reference lists of identified studies and generated and scanned reverse searches for appropriate studies. For systematic review inclusion, studies had to include a measure of ToM and assess alcohol use (i.e., quantity and/or frequency of drinking) or alcohol problems (e.g., AUDIT scores; see detailed description below) in non-clinical samples. For meta-analysis inclusion, studies had to provide data on the association between ToM and alcohol problems in non-clinical samples. Exclusionary criteria included nonhuman animal, non-English language, and non peer reviewed/unpublished studies.

Data extraction, coding, and statistical analysis

We extracted correlations for the association between ToM and alcohol problems (see Table 1 for a detailed list of measures used to assess ToM and alcohol problems). We also reached out to authors and requested statistics when they were not available.[5] A second study team member independently checked the extracted data for accuracy against the original articles. The few discrepancies that existed were resolved by team discussion. We ran analyses using Comprehensive Meta-Analysis (version 2.0) software (Borenstein et al., 2006), and final effect sizes were reported as Pearson's r.[6] The threshold for significance for all analyses was set at $p < 0.05$.

Each value contributing to an aggregate effect size was independent of all other values. Random-effects models were used for all analyses (Raudenbush et al., 1994). The heterogeneity of effect sizes across studies was measured with I^2 and tested with the Q statistics (Borenstein et al., 2006). When the heterogeneity test was significant, we tested for potential moderation by study quality, gender, and age. To test for study quality moderation, we assessed individual studies using relevant items from the adapted Quality Assessment Tool for Quantitative Studies (de Groot et al., 2019; see Scale S1). Study quality ratings were included as a continuous variable in moderation analyses using meta-regression. To test for age moderation, we ran a meta-regression using the mean age of participants in each study as a continuous moderator variable. To test for gender moderation, we ran a meta-regression using the percent of females in each study as a continuous moderator variable.

We evaluated publication bias by employing commonly used methods in the literature (i.e., Begg's rank correlation test (Begg & Mazumdar, 1994), visual inspection of funnel plots, and trim-and-fill methods (Duval & Tweedie, 2000)). Publication bias was assessed based on whether Begg's rank correlation tests were significant, there was considerable asymmetry in the funnel plots, and trim-and-fill models were substantially different from the tested models (Duval & Tweedie, 2000; Shi & Lin, 2019).

RESULTS

There were 126 total studies identified in the search (see Figure 1 for exclusions). Nine studies were included in the systematic review, and six studies, including 1098 individuals, were included in the meta-analysis.[7] The average study quality rating for studies in the meta-analysis was 2.00 (SD = 0.58), suggesting moderate quality (see Table 1). Moderate quality studies generally reported on selection bias (e.g., representativeness of target population, percentage of selected individuals who agreed to participate), study design (e.g., cross-sectional, longitudinal, experimental), confounders (e.g., appropriately adjusted for age, gender, education, SES), representativeness (e.g., reported numbers and reasons for participant drop-out rates), and clearly stated their hypotheses and inclusion/exclusion criteria.

Sample characteristics

Sample characteristics are displayed in Table 1. Final sample sizes ranged from $n = 25$ (Iorfino et al., 2016) to $n = 322$ (Innamorati et al., 2017). Two studies included only males (Iorfino et al., 2016; Romero-Martínez et al., 2013), while the remaining studies included both males and females. Mean ages for the samples ranged from 16.77 (Lannoy et al., 2020) to 50.48 (Balter et al., 2021). Five studies were conducted on European samples (Balter et al., 2021; Innamorati et al., 2017; Laghi et al., 2019; Lannoy et al., 2020; Romero-Martínez et al., 2013), and four studies were conducted on Australian samples (Iorfino et al., 2016; Lyvers et al., 2017, 2018, 2019).

ToM measures

ToM measures used in each study are shown in Table 1. As can be seen, of the nine identified studies, seven used the Reading the Mind in the Eyes Task (RMET; Baron-Cohen et al., 2001), one study additionally used Yoni's task (Shamay-Tsoory & Aharon-Peretz, 2007), and the final study used the Mentalizing Questionnaire (MZQ; Hausberg et al., 2012). The RMET and Yoni's task both assess the ability to infer the mental states of others based on eye region cues, which is thought to index decoding ToM. The MZQ assesses the ability to represent and understand inner mental states in oneself and others. This measure is thought to index reasoning ToM.

Meta-analytic results

Meta-analytic results examining associations between ToM and alcohol problems are shown in Table 2. As predicted, lower ToM was associated with more alcohol problems ($r = -0.16$, $k = 6$, CI = [−0.26, −0.04], $p < 0.01$), with a small effect size.[8] There was significant heterogeneity across studies ($Q = 15.55$, df = 5, $p < 0.01$, $I^2 = 67.85$), but this heterogeneity was not explained by gender ($\beta = 0.0003$, CI = [−0.006, 0.007], $z = 0.09$, $p = 0.93$), age ($\beta = -0.008$, CI = [−0.03, 0.01], $z = -0.82$, $p = 0.42$), or study quality ($\beta = -0.10$, CI = [−0.35, 0.15], $z = -0.82$, $p = 0.41$).

TABLE 1 Characteristics of articles included in the systematic review and meta-analysis

Study	Population	Measure of ToM	Measure of alcohol use/ problems	Mean age	Female gender %	Study quality
Balter et al., 2021	UK population: university and community sample (n = 87)	RMET – assesses ability to attribute emotional states of others based on eye gaze	Alcohol intake (units per week)	50.48	60.92%	2 = Moderate
Innamorati et al., 2017[a]	Italian population: community sample (n = 322)	MZQ – assesses ability to represent and understand inner mental states in oneself and other	MAST	35.30	58.10%	2 = Moderate
Iorfino et al., 2016[a]	Australian population: male community sample (n = 25)	RMET – assesses ability to attribute emotional states of others based on eye gaze	AUDIT	23.96	0.00%	1 = Weak
Laghi et al., 2019	Italian population: student sample (n = 170)	RMET – assesses ability to attribute emotional states of others based on eye gaze	Alcohol consumption, HED	18.71	37.65	2 = Moderate
Lannoy et al., 2020[a]	French population: student sample (n = 202)	Yoni's Task – assesses ability to infer mental states based on eye gaze cues	AUDIT, BD score	16.77	62.40%	2 = Moderate
Lyvers et al., 2017[a]	Australian population: university sample (n = 102)	RMET – assesses ability to attribute emotional states of others based on eye gaze	AUDIT	22.18	87.25%	2 = Moderate
Lyvers et al., 2018[a]	Australian population: university and community sample (n = 161)	RMET – assesses ability to attribute emotional states of others based on eye gaze	AUDIT	22.64	55.28%	2 = Moderate
Lyvers et al., 2019[a]	Australian population: university sample (n = 286)	RMET – assesses ability to attribute emotional states of others based on eye gaze	AUDIT	26.00[b]	61.10%[b]	3 = Strong
Romero-Martínez et al. (2013)	Spanish population: male community sample (n = 145)	RMET – assesses ability to attribute emotional states of others based on eye gaze	AUDIT	39.97	0.00%	2 = Moderate

Abbreviations: MZQ = Mentalizing Questionnaires; RMET = Reading the Mind in the Eyes Task; MAST = Michigan Alcohol Screening Test; AUDIT = Alcohol Use Disorders Identifications Test; HED = Heavy episodic drinking; BD score = Binge drinking score.

[a]Studies included in the meta-analysis on nonclinical samples.

[b]Values are based on the total sample size recruited for the study (n = 291). A subset of the total sample was used in the study (n = 286).

TABLE 2 Meta-analysis of studies assessing the association between ToM and alcohol problems in nonclinical samples

						Heterogeneity		
Outcome	**Study Authors**	***n***	***r***	**95% CI**	***p***	***Q***	I^2	***p***
Alcohol problems	Innamorati et al., 2017	322	−0.19	[−0.29, −0.08]	<0.01			
	Iorfino et al., 2016	25	0.03	[−0.37, 0.42]	0.90			
	Lannoy et al., 2020	202	−0.00	[−0.14, 0.14]	1.00			
	Lyvers et al., 2017	102	−0.03	[−0.22, 0.17]	0.77			
	Lyvers et al., 2018	161	−0.35	[−0.48, −0.21]	<0.001			
	Lyvers et al., 2019	286	−0.22	[−0.33, −0.11]	<0.001			
	Overall estimate		−0.16	[−0.26, −0.04]	<0.01	15.55	67.85	<0.01

Publication bias

Begg's rank correlation test resulted in null findings, suggesting no evidence for publication bias. Further, there was little evidence of publication bias based on visual inspection of funnel plots, trim-and-fill analyses, and imputation of missing studies (see Table S1, Table S2, and Figure S2).

DISCUSSION

Socio-cognitive mechanisms that contribute to social impairments found in AUD are unclear. Prior meta-analyses have found that individuals with AUD show deficits in ToM compared to healthy controls (Bora & Zorlu, 2016; Onuoha et al., 2016). However, no studies have extended these findings to examine whether deficits in ToM are reliably linked with alcohol problems in non-clinical (i.e., adolescent, young adult/college, adult) samples, which would support the idea that these deficits may also be a risk factor for the development of alcohol problems (e.g., Kumar et al., 2022; Winters et al., 2021). The current systematic review and meta-analysis examined associations between ToM and alcohol problems in non-clinical samples.

Sample characteristics and ToM measures

Most studies investigating links between ToM and alcohol use/problems in non-clinical samples were conducted on young adult European or Australian Caucasian samples; however, two studies included younger participants (mean ages in the teens), and one study included older adults (mean age in the 50s). Additionally, the majority of studies assessed decoding ToM, which measures the ability to infer the mental states of others based on eye region cues (e.g., Lannoy et al., 2020; Lyvers et al., 2017), with only one study assessing reasoning ToM, which measures the ability to infer others' intentions and beliefs (Innamorati et al., 2017). Future studies are needed to assess ToM and alcohol use/problems in more diverse nonclinical samples and in adolescent and older adult samples. Future studies should also examine the association between reasoning ToM and alcohol use/problems in nonclinical samples, rather than focusing almost exclusively on decoding ToM, as a prior meta-analysis found that individuals with AUD showed deficits in both the decoding the reasoning facets of ToM (Bora & Zorlu, 2016).

Meta-analytic results

Our meta-analysis found a small but reliable association between lower ToM and more alcohol problems in non-clinical samples. Significant heterogeneity was found across studies, but neither gender, age, nor study quality explained this heterogeneity. Long-term heavy alcohol use is often thought to explain deficits in ToM in individuals with AUD (Bora & Zorlu, 2016; Onuoha et al., 2016), but this meta-analysis demonstrates that links between ToM and alcohol problems also exist in non-clinical samples (i.e., individuals without a similar history of long-term and heavy alcohol consumption as those with AUD). Studies included in this meta-analysis were all cross-sectional, but the results align with the notion suggested by some researchers that deficits in ToM and related socio-cognitive constructs (e.g., empathy) may also precede the development of AUD and serve as a risk factor for problematic alcohol use (Kumar et al., 2022; Massey et al., 2018; Winters et al., 2021). Indeed, we recently reported a reliable association between lower empathy and heavier alcohol use and more alcohol problems in non-clinical samples, with comparable effect sizes to what was found here (Kumar et al., 2022).

Multiple mechanisms have been proposed to explain the link between ToM deficits and greater alcohol use and problems in non-clinical samples, including alcohol consumption for peer acceptance, misperceiving peers' attitudes about drinking, using alcohol as a coping mechanism in social situations, or because alcohol use is preferred over making social connections (Kuntsche et al., 2005; Laghi et al., 2019; Lyvers et al., 2019; Winters et al., 2021). Another proposed mechanism is that individuals with impaired social cognition (e.g., ToM, empathy) may especially benefit from alcohol's prosocial effects (Kumar et al., 2022). For

instance, a recent study showed that a low dose (0.24–0.29 g/kg) of alcohol, compared to a placebo, increased affective empathy in adult social drinkers ($N = 60$), and this effect was stronger for individuals with lower baseline trait empathy (Dolder et al., 2017). This increased sensitivity to alcohol's social rewards might lead individuals with socio-cognitive deficits to escalate their drinking and develop alcohol problems (Kumar et al., 2022). However, more research is needed to explore this hypothesis as one small ($n = 20$) study found that individuals who consumed 6–8 units (i.e., 48–64 grams) of alcohol showed impairments on ToM tasks in a bar setting compared to when they completed these same tasks while sober in their homes (Mitchell et al., 2011).[9] Importantly, though, it is currently unclear whether ToM deficits precede the emergence of AUD, are the result of chronic and heavy alcohol use, or both, since no prior studies have used longitudinal designs. Given the reliable association we report here between lower ToM and more alcohol problems in non-clinical samples, future studies employing more rigorous designs are needed to clarify the causal nature and direction between deficits in ToM and problematic alcohol use.

Limitations

This meta-analysis has limitations. First, we did not include unpublished studies, which may have led to inflated meta-analytical results, as unpublished studies typically show null findings. However, commonly used publication bias analyses did not indicate this. Second, we examined potential gender and age differences in the association between ToM and alcohol problems by accounting for the percent of females (vs. males) and using the mean age of participants in each study, respectively. Future studies are needed that examine socio-cognitive outcomes separately for males vs. females, and for younger vs. older individuals. This would allow for more definitive conclusions to be made about potential gender and age differences in the association between ToM deficits and alcohol problems. Third, we were unable to examine the association between ToM and excessive alcohol use (e.g., binge drinking) since only two studies reported these associations. Future studies should explore links between lower ToM and binge drinking among young people, since binge drinking may be a more valid indicator of alcohol misuse than alcohol problems alone (Cortés-Tomás et al., 2017; Piano et al., 2017). Fourth, all but one study included in the meta-analysis used tasks assessing decoding ToM (i.e., tasks that assessed the ability to infer the mental states of others based on eye region cues). As such, we were unable to test for moderation effects by ToM measure or determine whether the association with alcohol problems differed based on the decoding and reasoning facets of ToM. A prior meta-analysis found that individuals with AUD, compared to healthy controls, were impaired in both ToM-decoding and ToM-reasoning, with a moderate effect size for both associations (Bora & Zorlu, 2016; but see Maurage et al., 2016). As mentioned above, future studies are needed to determine whether deficits in both of these facets of ToM are present in non-clinical samples.

Finally, and also noted above, all of the studies included in this meta-analysis were cross-sectional in design. Therefore, future studies that employ more rigorous designs can help clarify the strength and direction of the associations between ToM deficits and alcohol problems. Longitudinal studies in particular can inform whether individuals with lower ToM are more likely to develop alcohol problems than those with higher ToM. Ecological momentary assessment studies that examine ToM processes and alcohol use in individuals' daily lives can additionally help clarify the temporal ordering of these associations. Finally, experimental research that manipulates ToM and measures alcohol outcomes and alcohol administration studies that manipulate alcohol consumption and measure ToM outcomes are also needed. Taken together, these study designs will help to elucidate whether ToM deficits predispose individuals to misuse alcohol, in addition to chronic heavy alcohol use causing ToM deficits. A reliable association between ToM deficits and alcohol problems in non-clinical samples will hopefully motivate these more rigorous study designs.

CONCLUSION

In summary, findings demonstrated that lower ToM is reliably associated with more alcohol problems in non-clinical samples. These cross-sectional associations provide some evidence that socio-cognitive deficits may serve as a risk factor for alcohol misuse (Kumar et al., 2022; Massey et al., 2018; Winters et al., 2021), but more research is needed to examine the effects of ToM and other socio-cognitive factors (e.g., empathy, emotion recognition) on alcohol use and problems. Longitudinal studies would be particularly helpful in determining whether deficits in ToM prospectively predict alcohol problems, and whether chronic and heavy alcohol use may lead to greater deficits.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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ENDNOTES

[1] The decoding and reasoning facets of ToM were not separately examined in this meta-analysis.

[2] Discrepancies in the search databases and search terms used across these two meta-analyses could explain the differences in studies included in each meta-analysis.

[3] We hoped to examine the moderating effect of different ToM measures, as well as moderation by decoding and reasoning facets of ToM (see Bora & Zorlu, 2016). However, we were unable to do so because there was little variation in the measures used across studies (i.e., five of the six studies used tasks assessing the ability to infer the mental states of others based on eye region cues, which indexes decoding ToM).

[4] We also hoped to meta-analyze associations between ToM and alcohol consumption (versus problems), but there were only two studies that reported these associations (Laghi et al., 2019; Lannoy et al., 2020). In both studies, deficits in ToM were linked to heavier alcohol consumption.

[5] See Figure 1 for information on article exclusions after contacting authors.

[6] Pearson's *r* of around 0.1 indicate small, 0.3 indicate medium, and 0.5 indicate large effect sizes (Cohen, 1992).

[7] Two studies (Balter et al., 2021; Laghi et al., 2019) were not included in the meta-analysis because they assessed alcohol use and not alcohol problems. One other study (Romero-Martínez et al., 2013) was excluded because the correlation value for the association between ToM and alcohol problems was not reported, and the authors were not able to provide such data upon request.

[8] Results were re-run excluding one study that included a small (n = 25) sample of male participants (Iorfino et al., 2016). Results did not change when excluding this study, so it was retained in the analyses.

[9] Since the environmental setting was not controlled for, it is unclear whether these effects were due to alcohol or setting.

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