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Social attunement and alcohol use: The role of age and gender

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ABSTRACT

Background: Alcohol use typically peaks during adolescence and early adulthood, when its social reinforcement value is high, and then decreases as individuals take on more adult-like responsibilities. The present study investigates whether social attunement (SA) plays a role in higher alcohol use in adolescence as well as a lower alcohol use when aging.
Methods: This online study included an international sample of 683 alcohol users (16 – 81yrs). Participants completed a SA Questionnaire, an Implicit SA task (ISAT), and measures of alcohol use. The ISAT measured SA as the change in willingness to drink in response to peer feedback between two blocks of images representing social alcohol, social non-alcohol, and social non-drinking settings. Linear regressions were conducted to assess the association between SA and alcohol use, and the role of age and gender in these associations.
Results: Unlike expected, interactions between age and SA did not predict alcohol use across social situations regardless of feedback condition. However, exploratory post-hoc analyses using the total SA score per social condition showed significant interactions between age and SA in predicting alcohol use in social situations involving non-alcoholic or no drinks. In social non-alcohol drinking settings, SA was positively associated with alcohol use among younger participants, but this association became negative in older individuals. Contrastingly, in the social non-drinking condition, SA was negatively associated with alcohol use among younger participants, but this association became positive in older individuals.
Discussion: Depending on age and social setting, SA can both be a risk- or protective factor for alcohol use.

1. Introduction

Alcohol use and alcohol use disorder (AUD) contribute to significant health concerns (Novier et al., 2015; UNODC, 2023), but prevalences vary across the lifespan (Dennis & Scott, 2007). Alcohol use generally peaks during adolescence and early adulthood, but most individuals eventually mature out by reducing consumption once they take on adult-like responsibilities (Cousijn et al., 2018; Lee et al., 2015; Littlefield et al., 2010; Steinberg, 2005). Social factors are known to play a major role in alcohol use initiation (D'Amico & McCarthy, 2006; Nesi et al., 2017), but the social plasticity hypothesis poses that they may also play a role in the process of maturing out (Cousijn et al., 2018). Specifically, social attunement (SA) has been linked to alcohol use and related problems (Kroon et al., 2023, 2024). SA is defined as the extent to which an individual aligns their behavior to harmonize with their social environment without explicit peer pressure (Cousijn et al., 2018; Kroon et al., 2023, 2024). Where high SA to peer alcohol use might result in initiation and escalation during adolescence and early adulthood when alcohol use has high social value, the same SA to a group that devalues alcohol use as they further progress into adulthood can result in subsequent reduction of use (Cousijn et al., 2018). This study aims to assess whether high SA to peer alcohol use during late adolescence and early adulthood is linked to increased alcohol use and related problems. At the same time, we expect this same SA to be associated with lower alcohol use and related problems also during early adulthood but at a later stage when individuals take on more serious responsibilities associated with

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adult life.

SA is relatively novel and has not been investigated in detail yet. It can be measured explicitly with self-report questionnaires and implicitly with behavioral tasks. Explicit social attunement (ESA) has been linked to higher alcohol use, especially in younger individuals (16 – 19yrs) with peers who engage in relatively heavy alcohol use (Kroon et al., 2023). Additionally, Kuhns et al. (2023) demonstrated that adolescents with higher ESA were more sensitive to social alcohol cues compared to non-social alcohol cues, while the opposite was the case in adults. Similarly, adolescents with higher ESA were more likely to increase their alcohol use over time, while in adults the opposite was the case (Kuhns et al., 2023). Thus, higher ESA may serve as a risk factor for escalating alcohol use during adolescence while simultaneously acting as a protective factor during adulthood.

The Implicit SA Task (ISAT; Kroon et al., 2024) measures participants' change in willingness to drink alcohol in different social settings with or without alcohol, after being presented with the willingness of fictitious peers to drink in those social settings. When presented with social settings including alcohol or soda, those participants that attuned more strongly towards higher peer willingness to drink had higher levels of alcohol use and related problems. Simultaneously, when presented with social settings without drinks, those who attuned more strongly towards lower peer willingness to drink had lower levels of alcohol use and related problems. Hence, ISA can be considered both a risk and a protective factor depending on the social situation and the peer group.

The present study also explored the role of gender identity in relation to age and SA. Kroon et al. (2024) previously found that on the behavioral subscale (i.e., the extent to which individuals report adjusting their behavior to harmonize with their social environment) of the SA Questionnaire (SAQ), men scored higher than women, indicating that men could be more prone to socially attuning their behavior to their social environment compared to women. Furthermore, men are known to drink more than women (Goh et al., 2024; Holmila & Raitasalo, 2005; Oncini and Guetto, 2018; Wilsnack et al., 2018). These differences in drinking behavior and SA highlight the importance of assessing the role of gender.

To test the social plasticity hypothesis (Cousijn et al., 2018), the primary aim of the present study was to assess whether the association between ISA and ESA and alcohol use and related problems was moderated by age. We hypothesized that the association was positive during adolescence and early adulthood, but negative as individuals progress into adulthood (Kuhns et al., 2023). The secondary aim was to assess whether the role of age was subsequently moderated by gender identity. However, given the purely exploratory nature of this analysis, no specific direction of this association was hypothesized.

2. Methods

2.1. Sample

In total, 811 participants participated in the study, which was conducted in two waves. Wave one (2022) included 534 participants (earlier publication: Kroon et al., 2024) and wave two (2023–2024) included 277 participants. A total of 28 participants failed to complete the main task (Implicit SA task) and were excluded from the analyses. Furthermore, 81 non-alcohol-drinkers and 19 participants with a non-binary gender identity were excluded, resulting in a final analysis sample of 683 participants. Recruitment of participants took place via social media, the Erasmus University participant pool, and in-person flyer distribution (the Netherlands). For the second wave, participants were also recruited through prolific (Prolific, 2024). Advertisements targeted cannabis and alcohol users, and no inclusion/exclusion criteria apart from proficiency in Dutch or English and age over 15 were applied. All participants received an information letter and signed informed consent before participating. The full study protocol was approved by the Ethics Review Committee of Erasmus University Rotterdam (ETH2122-0311).

2.2. Procedure

The one-hour study took place fully online. Tasks and questionnaires were in Dutch or English depending on participant proficiency. The session was divided into two blocks of questionnaires that were separated by a series of experimental tasks. The first block contained questionnaires on demographic variables and the second block included questionnaires related to substance use and mental health. At the end of the study, participants received information on possible ways to seek help for substance use problems or mental health related issues. Compensation was given by means of entering a raffle through which one in five participants received a gift card of ten euros, as well as a raffle of four prepaid credit cards of 50 euros to be divided over all participants.

2.3. Measures

2.3.1. Questionnaires

Social attunement

ESA was measured using the 11-item SAQ (Kroon et al., 2023). Every item was rated on a 7-point Likert scale (1 = "completely disagree" to 7 = "completely agree"), reliability measures from a validation study (Kroon et al., 2023) in a sample of participants aged between 16 and 78 indicated acceptable internal consistency (Cronbach's Alpha = 0.75).

Other questionnaires

Single item questions were used to assess age, gender identity, sex, nationality, alcohol use age of onset, and highest completed level of education. Education levels from international participants were recoded to the Dutch education system (Table S1). The Alcohol Use Disorder Identification Test (AUDIT; Hildebrand & Noteborn, 2015; Saunders et al., 1993) was used to measure alcohol use and related problems. A score of 8 or above is considered indicative of at-risk alcohol use (Bador et al., 2001). The Timeline Follow Back (TLFB; Robinson et al., 2014) was used to measure the number of standard alcohol units, cannabis use (in grams), and cigarette use within the 14 days prior to participating in the study. Binge drinking was assessed using a single item question in which participants indicated the number of days in the past year during which they consumed at least five standard alcoholic drinks consecutively (within a few hours). Participants self-reported on their lifetime use of cannabis, tobacco, and other drugs ("which of the following substances have you ever used?").

2.3.2. Implicit social attunement task

The Implicit SA Task (ISAT; Kroon et al., 2024), was used to assess ISA. The ISAT was separated into two blocks. During the first block, 45 images were displayed in a fixed order showing an equal number of images with a social alcohol drinking (SAD), social non-alcohol drinking (SNAD), and a social non-drinking setting (SND; Fig. 1; Table 1). Participants were instructed to imagine being present in the social situation that was shown and to indicate their willingness to consume alcoholic drinks in that situation on a scale from 1 to 10 (1 = no desire to drink, 10 = strong desire to drink). Immediately after responding, participants were shown peer feedback (willingness to drink from a fictional peer group). Peer feedback was semi-randomly generated based on the participants' response. In six trials (two per social setting), that were on the same locations for all participants, peer feedback was identical to the participants' response. In the remaining 39 trials, there was a 50% probability of receiving either "higher" or "lower" peer feedback. This feedback had a 70% probability of being a large difference (2–3 points) from the participants' response and a 30% probability of being a small difference (1 point). After the first block, an 11-minute working memory task was completed. During the second block, the same images were shown in the same order. Again, participants were asked to rate their willingness to drink but no peer feedback was provided this time.

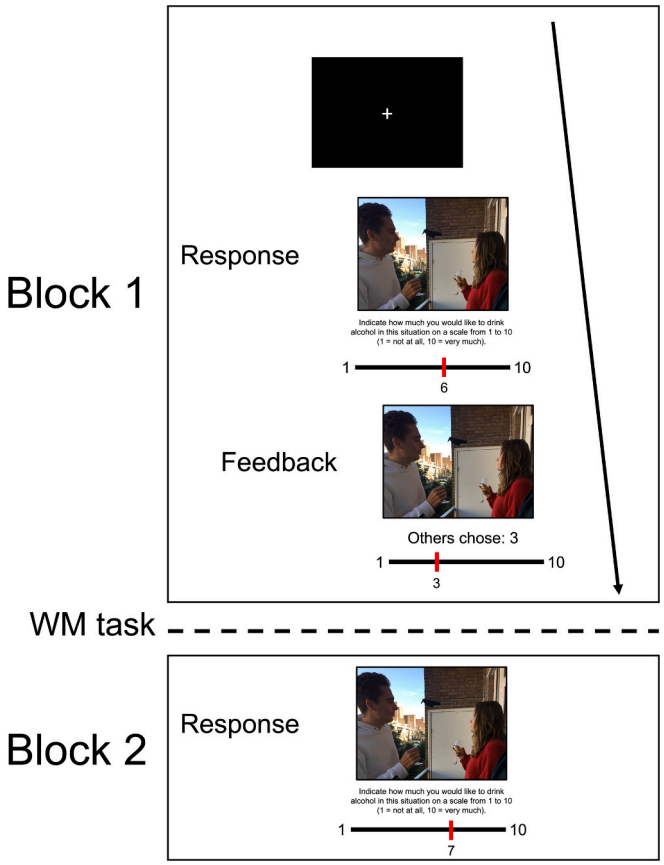

Fig. 1. Illustration of the implicit social attunement task. During the first block, images were shown with a social alcohol drinking (SAD), social non-alcohol drinking (SNAD), and a social non-drinking setting (SND). Participants were asked to imagine being present in the social setting that was illustrated and to indicate their willingness to consume alcoholic drinks in that situation on a scale from 1 to 10 (1 = no desire to drink, 10 = strong desire to drink). Immediately after responding, participants were shown peer feedback (willingness to drink from a fictional peer group). In between blocks, an 11-minute working memory task was completed. In the second block, the same images were shown in the same order, without peer feedback.

ISA scores were divided into two main categories, ISA + scores represent changes in willingness to drink following trials with positive peer feedback (i.e., higher willingness to drink compared to the participant's rating at baseline). ISA − scores represent changes in willingness to drink following trials with negative peer feedback (i.e., lower willingness to drink compared to the participant's rating at baseline). Both ISA scores were computed for each participant for each social condition (SAD+, SAD-, SNAD+, SNAD-, SND+, SND-; Table 1), controlling for general (i.e., change in response to same feedback trials) changes in willingness to drink, using the following formulas: ISA+ = (block 2 willingness to drink – block 1 willingness to drink) − difference scores on same feedback trials & ISA− = −1 × ((block 2 willingness to drink – block 1 willingness to drink) – difference score on same feedback trials). Because of the response-probabilistic feedback in the ISAT, participants who repeatedly indicated very low or very high willingness to drink across trials received limited feedback in one direction (e.g., someone who repeatedly indicated 10 could not receive positive feedback, as 10 was the maximum score). Therefore, social setting-feedback type combinations with less than two trials were excluded from the analysis. Exploratory analyses were conducted to assess the effect of social setting by averaging ISA + and ISA- scores for each social setting, resulting in ISA total scores for each social condition.

2.4. Data analysis

Separate linear regressions were conducted with each of the ISA Task conditions or SAQ score as predictors of AUDIT scores, TLFB scores, and binge drinking days. In subsequent models, age and the age by SA interaction were included, followed by a third model in which gender was included to form three-way interactions (Fig. 2). Bootstrapping (10000 resamples) was used to generate more robust estimates of confidence intervals and AUDIT scores (square root), TLFB scores (log), and binge drinking days (log) were transformed to account for assumption violations. All analyses have been preregistered and non-registered analysis are explicitly noted as being exploratory. We deviated from the preregistration by only using bootstrapping for the confidence intervals, not the main analysis, to facilitate the interpretation of effect sizes. For all models, Holm's correction for *p*-values was applied across SA conditions for each alcohol use outcome measure separately All statistical analyses were performed in JASP (JASP Team, 2025).

3. Results

3.1. Sample characteristics

Participants had an average age of 34.25 (SD = 14.60) years and most participants completed (pre-) university education (88.60 %), identified as female (53.00 %), and were not Dutch (66.60 %; Table 2). Participants scored an average of 7.34 (SD = 5.63) on the AUDIT. Almost 39 % scored at least 8 on the AUDIT, which is indicative of at-risk use (Saunders et al., 1993). On average, participants had 25.76 (SD = 6.00) days of binge drinking during the past year and consumed 16.27 (SD = 9.00) standard alcohol units within the past two weeks.

3.2. Associations between age, gender, social attunement and alcohol use

3.2.1. Age and gender

Across models, age and gender consistently emerged as significant predictors of alcohol use. Age was negatively associated with AUDIT scores and binge drinking days, but positively associated with TLFB scores (Tables S2 – S11). Furthermore, men scored higher than women on the AUDIT, TLFB, and binge drinking days (Tables S2 – S11).

3.2.2. Explicit social attunement

Only in the simple linear regression (R^2 = 0.012, F(1, 681) = 9.088, p = 0.018), SAQ scores were positively associated with AUDIT scores (B = 0.012, t(681) = 3.015, p = 0.018, CI [0.004, 0.019]; Table S2). No associations between SAQ and TLFB scores and binge drinking days were observed (Table S2). Furthermore, no interactions between SAQ scores and age or gender were observed in any of the alcohol use measures (Table S2).

3.2.3. Implicit social attunement

Social alcohol drinking settings: SAD + scores were not associated with AUDIT scores, TLFB scores, and binge drinking days, and no interactions between SAD + scores and age or gender were observed (Table S3). SAD- scores were not associated with AUDIT scores, TLFB scores, and binge drinking days, and no interactions between SAD- scores and age or gender were observed (Table S4).

Exploratory post-hoc analyses revealed that SAD total scores were not associated with AUDIT scores, TLFB scores, or binge drinking days in any of the models (Table S9). Furthermore, no interactions between SAD total scores and age or gender were observed (Table S9). These results suggest that changes in willingness to drink in response to peer feedback in social alcohol drinking situations, were not linked to alcohol use and use-related problems.

Social non-alcohol drinking settings: In the simple linear regression (R^2 = 0.015, F(1, 670) = 10.064, p = 0.014), SNAD + scores were positively associated with AUDIT scores (B = 0.100, t(670) = 3.172, p =

Table 1
Implicit social attunement task characteristics.

Block	Condition	Trial type	# of trials	Stimulus type	Peer feedback	Feedback details	Feedback generation
Block 1	Social alcohol drinking	SAD+	~ 0 – 13*	Images of social setting with alcoholic drinks	Yes	Feedback > participant response	Randomized
		SAD-	~ 0 – 13*			Feedback < participant response	Randomized
		SAD=	2			Feedback = participant response	Fixed
	Social non-alcohol drinking	SNAD+	~ 0 – 13*	Images of social setting with non-alcoholic drinks		Feedback > participant response	Randomized
		SNAD-	~ 0 – 13*			Feedback < participant response	Randomized
		SNAD=	2			Feedback = participant response	Fixed
	Social non-drinking	SND+	~ 0 – 13*	Images of social setting with no drinks		Feedback > participant response	Randomized
		SND-	~ 0 – 13*			Feedback < participant response	Randomized
		SND=	2			Feedback = participant response	Fixed
WM task	–	–	–	–	–	–	–
Block 2	All conditions	–	45	Repeated images from block 1	No	–	–

Note.*: Due to the response probabilistic feedback, the number of trials with positive and negative feedback within each social condition varied (i.e., participants who always responded 1 could only receive positive feedback, while those who always responded 10 could only receive negative feedback); SAD: social alcohol drinking setting; SNAD social non-alcohol drinking setting; SND: social non-drinking setting; +: positive feedback on willingness to drink; −: negative feedback on willingness to drink; =: feedback identical to the participant's response.

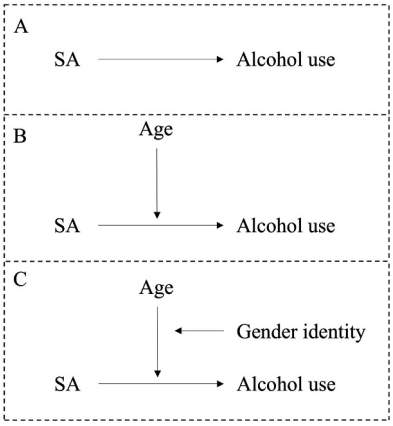

Fig. 2. Conceptual diagram illustrating the stepwise model construction. (A) Main effect model assessing the association between social attunement (SA), and alcohol use. (B) Adding age to the model to form two-way interactions with SA. (C) Adding gender identity to the model to form two-way and three-way interactions between SA, age, and gender. Each model was run separately for each social attunement measure and alcohol use measure.

0.014, CI [0.038, 0.162]; Table S5), suggesting that those who were more inclined to increase their willingness to drink in line with positive peer feedback during social non-alcohol drinking situations, were also more likely to have higher AUDIT scores. No interactions between SNAD + scores and age or gender were observed in any of the alcohol use measures (Table S5). SNAD- scores were not associated with AUDIT scores, TLFB scores, or binge drinking days in any of the models and no interactions between SNAD- scores and age or gender were observed (Table S6).

Exploratory post-hoc analyses showed that SNAD total scores were not associated with AUDIT scores, TLFB scores, or binge drinking days in any of the models (Table S10). However, an interaction between SNAD total scores and age was observed ($R^2 = 0.031$, $F(3, 576) = 6.155$, $p < 0.001$); younger participants who were more likely to change their willingness to drink in line with peer feedback in social non-alcohol drinking situations were also more likely to have higher AUDIT scores, whereas for older participants the opposite pattern was found (B = -0.004, $t(576)$ = -2.303, $p = 0.044$, CI [-0.007, −0.001]; Fig. 3, panel C; Table S10).

Social non-drinking settings: SND + scores were not associated with AUDIT scores, TLFB scores, or binge drinking days in any of the models (Table S7). Furthermore, no interactions between SND + scores and age or gender were observed (Table S7). Also, no associations between SND- scores, AUDIT scores, TLFB scores, and binge drinking days were observed in any of the models (Table S8). These results suggest that changes in willingness to drink in response to peer feedback across trials with illustrations of social situations that contained no drinks, were not linked to alcohol use and use-related problems.

Exploratory post-hoc analyses demonstrated that SND total scores were not associated with AUDIT scores, TLFB scores, or binge drinking days in any of the models (Table S11). However, an interaction between SND total scores and age was observed ($R^2 = 0.025$, $F(3, 305) = 2.614$, $p = 0.051$); younger participants who were more likely to change their willingness to drink in line with peer feedback in social non-drinking situations were also less likely to have higher AUDIT scores, whereas for older participants the opposite pattern was found ($B = 0.009$, $t(305) = 2.547$, $p = 0.033$, CI [0.001, 0.017]; Fig. 4, panel C; Table S11). Furthermore, another interaction between SND total scores and age was observed ($R^2 = 0.033$, $F(3, 305) = 3.464$, $p = 0.051$); younger participants who were more likely to change their willingness to drink in line with peer feedback in social non-drinking situations were also less likely to have higher TLFB scores, whereas for older participants the opposite pattern was found ($B = 0.010$, $t(3, 305) = 2.451$, $p = 0.045$, CI [0.003, 0.018]; Fig. 5, panel C; Table S11).

4. Discussion

This study aimed to assess whether the association between implicit and explicit SA and alcohol use and related problems was dependent on age, as proposed in the social plasticity hypothesis (Cousijn et al., 2018). In contrast to our hypotheses, we observed no significant effect of age on the association between SA and alcohol use in any of the originally pre-registered analyses. However, interactions with age emerged in post-hoc

Table 2
Sample characteristics.

Categorical Variables	Description	N	%
Gender Identity*	Male/Female	321/362	47.00/53.00
Nationality	Dutch/Other	228/455	33.40/66.60
Education Level	Less than high school/(pre-) vocational or college/(pre-) university/Other	11/33/605/34	1.60/4.80/88.60/5.00
Cannabis Lifetime Use	Yes/No	459/224	67.20/32.80
Tobacco Lifetime Use	Yes/No	497/186	72.00/27.20
Other Lifetime Drug use**	Yes/No	301/382	44.07/55.93
At-risk alcohol use (AUDIT $\geq$ 8)	Yes/No	264/419	38.65/61.35

Continuous Variables	Mean	Median	SD	N	Range
Age	34.25	29.00	14.60	683	16 – 81
Explicit social attunement (SAQ)	43.26	44.00	10.37	683	11 – 69
Alcohol use and related problems (AUDIT – Total)	7.34	6.00	5.63	683	0 – 34
Alcohol use (AUDIT – item 1–3)	4.19	4.00	2.40	683	0 – 12
Alcohol use related problems (AUDIT – item 4–10)	3.14	2.00	3.79	683	0 – 24
Alcohol use age of onset	15.25	15.00	3.32	683	5 – 54
Binge drinking days last year	25.76	6.00	52.04	677	0 – 365
Last 14-day alcohol use (TLFB – standard drinks)	16.17	9.00	22.96	683	0 – 196
Last 14-day cannabis use (TLFB – grams)	2.34	0.00	8.84	459	0 – 140
Last 14-day cigarette use (TLFB – cigarettes)	43.76	0.00	89.00	497	0 – 700

Note. AUDIT: Alcohol Use Disorder Identification Test; SAQ: Social Attunement Questionnaire; TLFB: timeline follow-back; *: those who identified as non-binary were excluded from the analysis due to the limited sample size, which prevented accurate estimates of associations related to this group; **: XTC/MDMA, cocaine, laughing gas, GHB, psychedelic mushrooms, LSD, ketamine, and methamphetamine.

exploratory analyses using the total ISA scores (i.e., implicit social attunement regardless of peer feedback being positive or negative). First, younger individuals who more strongly adapted their willingness to drink alcohol to peer willingness in settings with non-alcoholic beverages (SNAD) showed more alcohol use and use-related problems, while the opposite pattern was observed in older individuals. Second, younger individuals who more strongly adapted their willingness to drink alcohol to peer willingness in settings without drinks (SND) showed less alcohol use and use-related problems, while the opposite was observed in older individuals.

The social plasticity hypothesis posits that SA may draw adolescents towards heavy alcohol use, particularly given the high social reinforcing value of alcohol during this developmental period (Cousijn et al., 2018). However, high SA may protect adults against heavy alcohol use when the social reinforcing value of heavy alcohol use decreases, at least partially due to the adoption of more serious adult-like responsibilities. The observed findings in settings with non-alcoholic beverages are in line with this hypothesis. While the opposing findings in the settings without any drink are more difficult to explain, they stress the importance of social context and potentially also the age-appropriate norms in those settings. Hence, we hypothesized that the association between SA and alcohol use would vary across age. The current results add to this theory by showing that age-related effects may vary across different social contexts. Speculatively, SA may function as a risk factor for youth when the implicit norm is to drink soda, and as a risk factor for adults and older adults when the norms regarding alcohol are ambiguous. However, more research is needed to investigate this.

The absence of an interaction effect in any of the specific valenced feedback conditions suggests that the general tendency to attune to peers explains more age-related variance in alcohol use than attunement to positive and negative feedback in isolation. This might suggest that whether peers are more positive or negative may not really matter, further supporting the importance of the precise social context and the need to experimentally investigate this.

Although not focusing on age specifically, two other studies compared substance use across different social settings. Larsen et al. (2022) compared neural activity and willingness to drink when exposed to simultaneous visual and audio social alcohol or neutral (water) cues. Whole-brain and region of interest analyses showed that activity in both conditions was consistently correlated with alcohol use measures, suggesting that the social context itself rather than the type of substance induces willingness to drink. Notably, Larsen et al. (2022) contained a relatively young sample only consisting of young adults, whereas our study included participants from across the lifespan. As such, it might be that the type of social setting does matter, only that the direction of the effect depends on age and whether (non–)alcoholic drinks are present. Furthermore, Larsen et al. (2018) tested an audio simulation, mimicking different social situations where students were offered cigarettes. Findings indicated that participants showed differences in smoking behavior associated with different social contexts (i.e., more intimate settings elicited higher willingness to accept cigarettes). This suggest that the type of social context may influence substance use, but that this effect may be dependent on the type of substance involved.

Furthermore, it has been shown that different types of experienced social reward such as admiration, prosocial tendencies, passivity, and negative social potency tend to vary across both age and gender (Altikulaç et al., 2019). However, how each of these aspects as well as other social cognitive constructs relate to alcohol use across age remains unknown. The majority of studies focusing on alcohol use disregard the social context in which the majority of alcohol use takes place (Creswell & Fairbairn, 2025; Fairbairn & Kang, 2025), further highlighting the need for studies that focus specifically on how social factors relate to alcohol use which remains largely unexplored.

The social plasticity hypothesis (Cousijn et al., 2018) puts a strong emphasis on social factors and the findings of the present study suggest that SA might be considered a risk factor as well as a protective factor depending on age and the social (non–)drinking context. However, it is important to note that not all drinking occurs in social settings, and that actually those who drink alone might be more at risk of developing problematic alcohol use, as explained in the social-contextual framework by Creswell (2021). Studies show that both adolescents and adults who report to drink alone show more use and use-related problems compared to peers who reported to drink exclusively socially (Mason et al., 2020; Skrzynski & Creswell, 2020). Furthermore, solitary alcohol use during adolescence has been associated with more use and use-related problems during early adulthood compared to social drinkers (Creswell et al., 2014). Hence, it may be that individuals who tend to drink more alone might not benefit from the protective influence of social expectations that coincide with transitioning into adulthood, and consequently may be less likely to mature out of problematic substance use.

The secondary aim of the study was to assess whether the role of age is subsequently moderated by gender identity. Men generally drank more, but we observed no effect of gender in the association between SA and alcohol use. Age was negatively associated with problematic alcohol use, but positively associated with consumption. Furthermore, we observed no effect of gender on the interaction between age and SA in relation to alcohol use. It could be that SA operates similarly across gender. However, the role of gender may vary by social context, and the images in the ISAT may have depicted social situations where men and

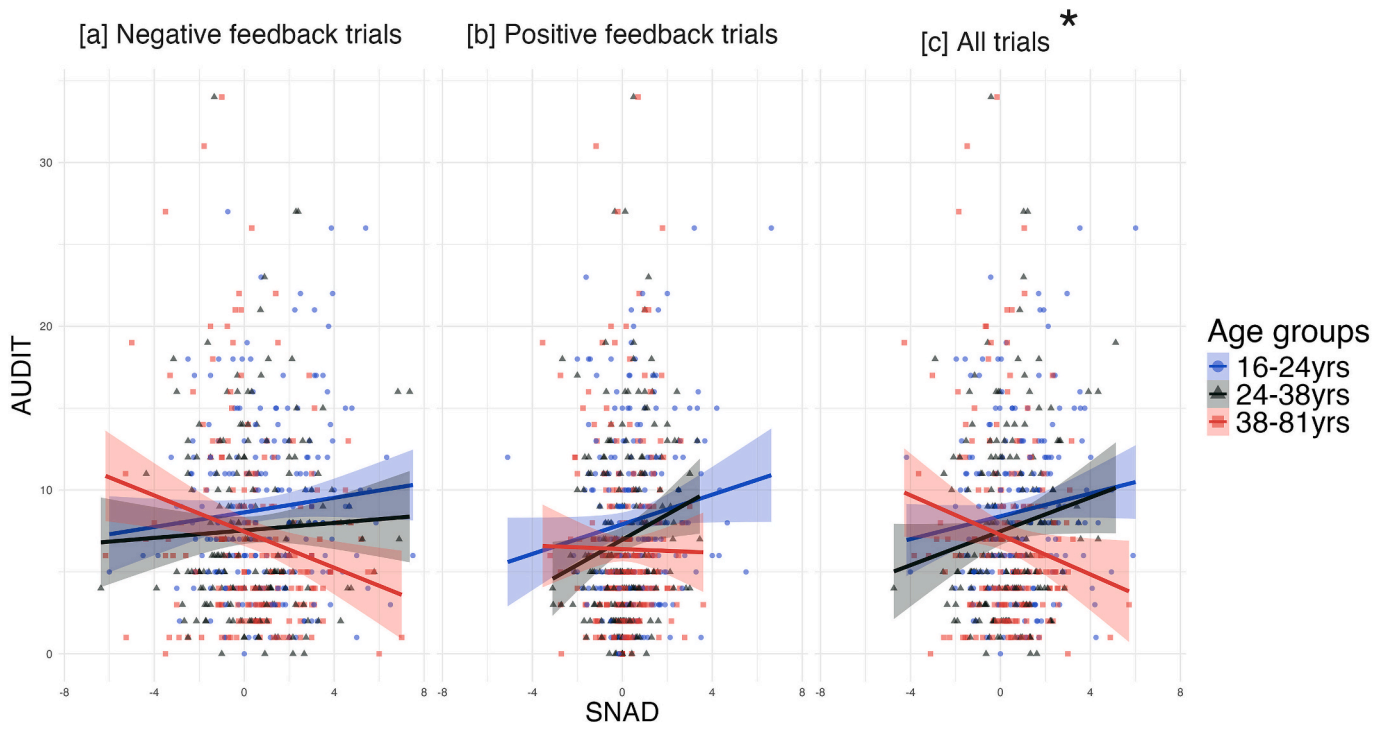

Fig. 3. Associations between social non-alcohol drinking scores and alcohol use disorder symptoms moderated by age. AUDIT: Alcohol Use Disorders Identification Test; SNAD: social non-alcohol drinking setting scores; *: significant interaction effect (all trial scores combined*age; $p = 0.044$). A tertiary split was applied to visualize the continuous effect of age.

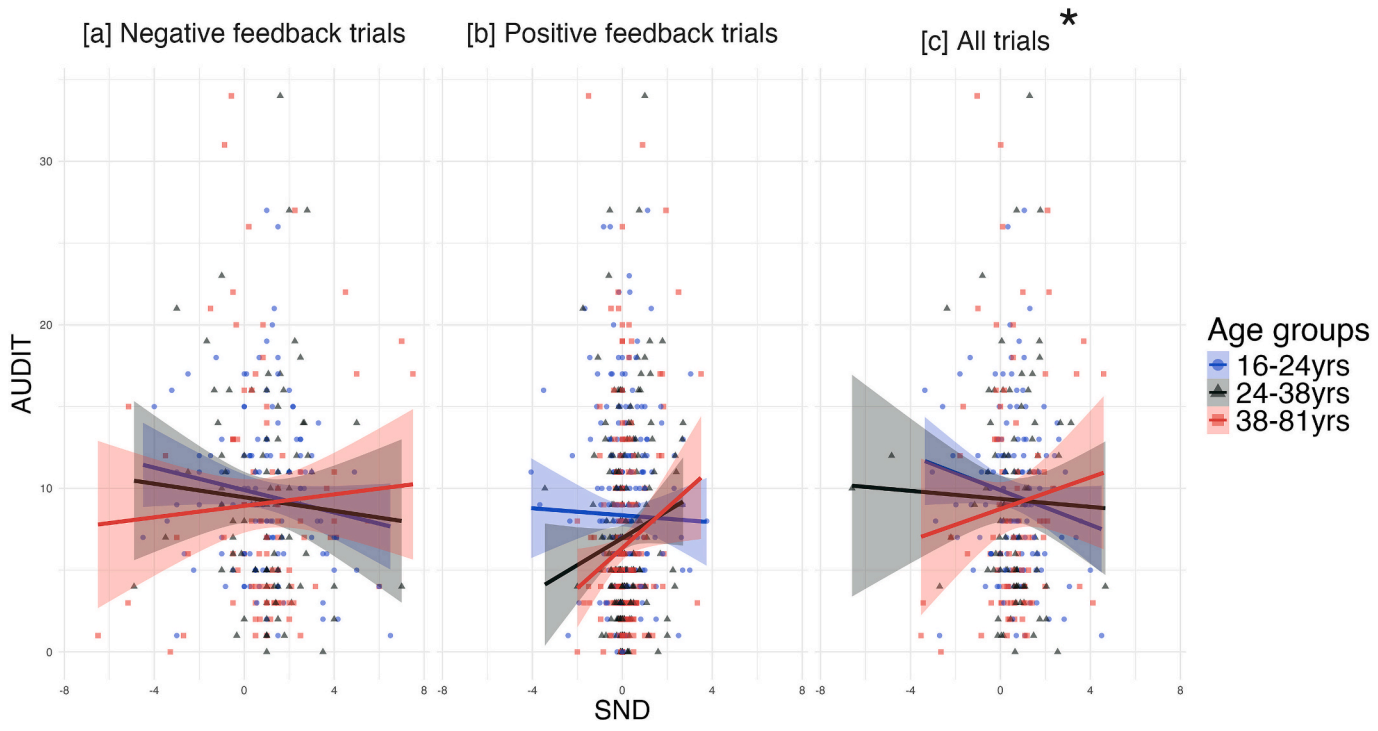

Fig. 4. Associations between social non-drinking scores and alcohol use disorder symptoms moderated by age. AUDIT: Alcohol Use Disorders Identification Test; SND: social non-drinking setting scores; *: significant interaction effect (all trial scores combined*age; $p = 0.033$). A tertiary split was applied to visualize the continuous effect of age.

women behave similarly. Images systematically depicting groups with variable gender composition and settings such as workplaces, bars, and nightclubs could help assess whether gender differences emerge in context-specific environments.

Given the limited research focusing on the role of age in relation to SA and social influence – which is closely related to, but distinct from SA– interpretations remain speculative. Adolescents and young adults may consider drinking norms during SNAD settings as more ambiguous

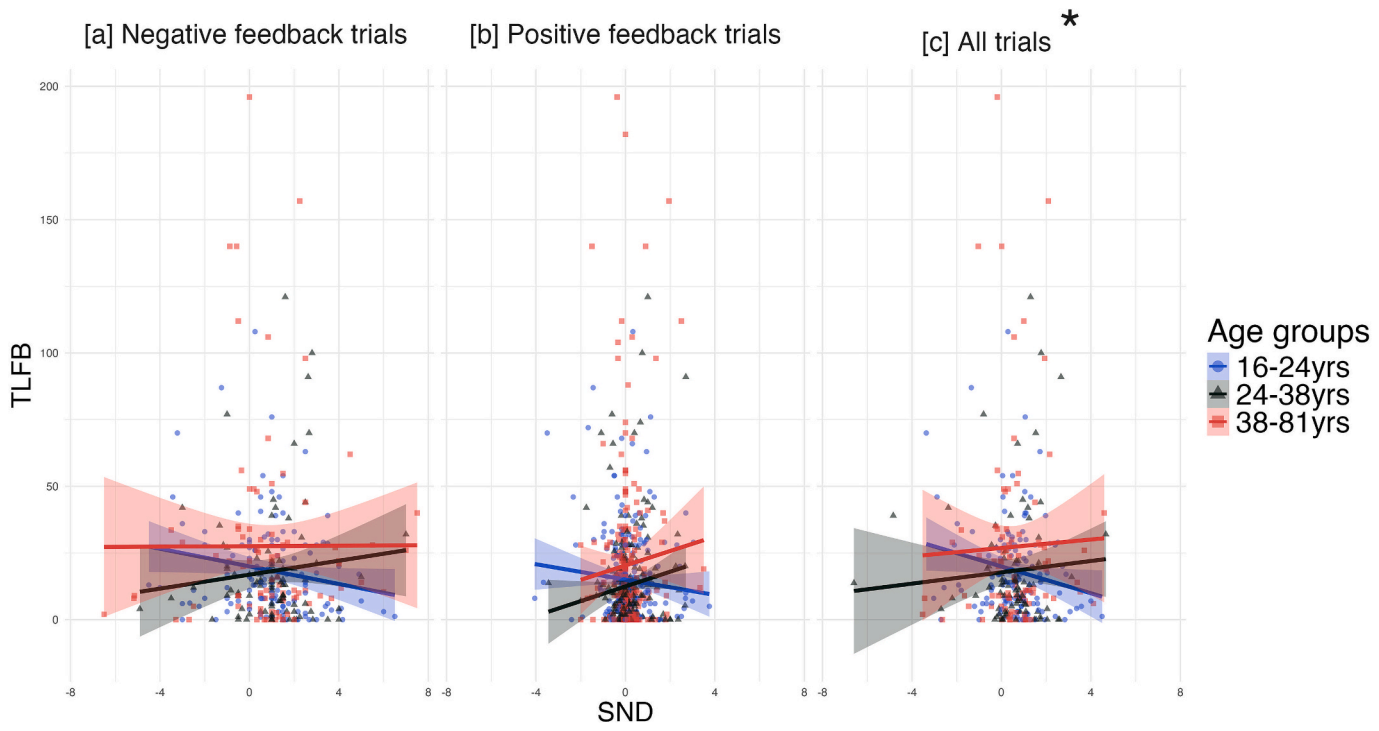

Fig. 5. Associations between social non-drinking scores and alcohol use moderated by age. TLFB: Timeline followback; *: significant interaction effect (all trial scores combined*age; $p = 0.045$. A tertiary split was applied to visualize the continuous effect of age.

compared to older adults. In moments of doubt, younger individuals more attuned to peer feedback may show more alcohol use and related problems, coinciding with the period of life when the social reinforcement value of alcohol use is at its peak (Cousijn et al., 2018). Simultaneously, older individuals have more developed self-control (Steinberg, 2005), are less inclined to engage in risky behavior compared to adolescents (Gardner & Steinberg, 2005), and have better developed social cognition (Burnett et al., 2011). Older individuals might interpret the presence of non-alcoholic drinks as an explicit sign that consuming alcohol is socially inappropriate. During the SND condition, the drinking context is clearly unambiguous. Younger individuals more attuned to peer feedback during SND settings may be less inclined to consume alcohol. As individuals age, drinking behavior might become more routine. Especially after the age of 50, individuals consider drinking to be an important aspect of sustaining social relations which they deem important for their well-being (Bareham et al., 2019). Consequently, the social (non–)drinking context in which drinking takes place may become less relevant in deciding to consume alcohol, as individuals might choose to drink regardless, as long as the context is social.

Although our study has a relatively large sample size and included participants across almost the entire lifespan, several limitations must be noted. The cross-sectional study design prevented us from determining whether the associations in the social non-alcohol and social non-drinking situations truly shifted within participants from negative to positive and vice versa over time, limiting the extent to which causal inferences can be made. Furthermore, the proportion of at-risk alcohol users is relatively low (Table 2), impacting the generalizability of the results to heavier users. Although the sample included a wide age range, it was skewed toward younger individuals, warranting replication in an older cohort. The age range of the sample used in the present study slightly exceeded the range for which the SAQ was validated (Kroon et al., 2023). However, given the small magnitude of the difference, this is unlikely to pose a substantial concern for our findings. The ISAT may be less suitable for older individuals, since the images only contain young people, potentially making it more difficult for older participants to relate to the images compared to younger participants. The task could, however, easily be adapted with images of older individuals to accommodate this respective age range. Furthermore, excluding non-binary participants ($n = 19$) limits the generalizability of the findings pertaining to gender identity. Additionally, as the ISAT and SAQ measure SA in a controlled setting. Replication in a naturalistic bar-lab study (e.g., Larsen et al. 2010) could clarify real-world generalizability. Notably, the significant interaction effects with age explained only a small proportion of the variance, suggesting other contributing factors remain unexplored. Given that this study aimed to explore the role of age, we included a wide range of social setting – feedback type combinations in our analyses. This broad approach necessitated strict corrections to control for type I error, which in turn reduced the likelihood of detecting statistically significant effects.

Overall, depending on age and social setting, SA appears to play a role in both the increase as well as the decrease in alcohol use and use-related problems. This effect emerges only in social settings depicted without the presence of (alcoholic) beverages. Thus, SA may protect younger individuals in settings where non-alcoholic drinks are present but pose a risk for older individuals, while the opposite pattern is observed in social settings where no drinks are present. Therapeutic interventions may consider the individual's age, social settings in which alcohol is used most, and potential reliance on non-alcoholic alternatives. Furthermore, when assessing the role of age in relation to risk and resilience to AUD, therapeutic interventions and prevention strategies should look further than only social situations where alcohol is consumed. Greater benefit may be achieved by focusing on social contexts where alcohol is not readily available or not socially normative, as individuals may have more potential to change their behavior in those settings compared to situations when drinking is already the norm. Examining the role of age in relation to SA and alcohol use remains crucial to identify individuals who might be at greater risk of failing to mature out of problematic substance use and developing long-term substance use-related problems.

The research questions, hypotheses, and analyses have been pre-registered via the open science framework: https://doi.org/10.17605/OSF.IO/HTJ6Y.

CRediT authorship contribution statement

Christophe Romein: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Karis Colyer-Patel:** Writing – review & editing, Methodology, Data curation. **Emese Kroon:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation. **Helle Larsen:** Writing – review & editing, Supervision. **Hanan El Marroun:** Writing – review & editing, Supervision, Funding acquisition. **Janna Cousijn:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Data curation, Conceptualization.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Janna Cousin reports financial support was provided by European Commission. Hanan El Marroun reports was provided by Volksbond Foundation Rotterdam. Hanan El Marroun reports was provided by Dutch Research Council. Janna Cousijn reports a relationship with Addiction Journal that includes: board membership. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2025.108587.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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