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Triple Spirals? A Three-Wave Panel Study on the Longitudinal Associations Between Social Media Use and Young Individuals' Alcohol Consumption

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Abstract

The present longitudinal study ($N=596$, $M_{\text{age at baseline}}=16.96$, $SD=.78$) combines an interdependent social media effects approach with Slater's reinforcing spirals model. As such, it is the first study to test a triple spiral between self-sharing of and exposure to alcohol-related content on social media, self-sharing and drinking behavior, and exposure and drinking behavior. We thereby differentiate between within-level and between-level relationships using a random intercepts cross-lagged panel model (RI-CLPM). The results indicate that there is a positive significant relationship between sharing, exposure, and consumption at the between-person level: Across waves, individuals who reported higher alcohol consumption also reported more frequent self-sharing, and those who reported more frequent self-sharing also reported more frequent exposure. Within-person change in self-sharing, exposure, and consumption are associated cross-sectionally, but these relationships do not endure over time. These results demonstrate that alcohol-related communication on social media effects may reflect a subgroup of heavy drinking adolescents who also share about their drinking behavior.

Keywords: alcohol, social media, reinforcing spirals, media effects, random intercepts cross-lagged panel model, adolescents, media psychology.

Triple Spirals? A Three-Wave Panel Study on the Longitudinal Associations Between Social Media Use and Young Individuals' Alcohol Consumption

In many parts of the world, alcohol consumption is deeply ingrained in people's social lives. Alcohol is typically consumed for pleasure and is associated with friendship, fun, sociability, hospitality, and celebration (Heath, 2000; Niland, Lyons, Goodwin, & Hutton, 2013). For adolescents and emerging adults in particular, the pleasures of drinking alcohol stem from having fun with friends, and they enjoy recounting their drinking experiences via stories and photographs (Hebden, Lyons, Goodwin, & McCreanor, 2015; Niland et al., 2013; Niland, Lyons, Goodwin, & Hutton, 2014). With the rise of social media, such as Facebook, drinking stories and photographs have increasingly found their way online, and studies indicate that alcohol-related content has become omnipresent on social media (Beullens & Schepers, 2013; Moreno, Arseniev-Koehler, Litt, & Christakis, 2016; Niland et al., 2014). Consequently, researchers have become increasingly interested in the roles that social media can play in young individuals' drinking behavior, and new areas of research that focus on *social* rather than *traditional* media effects are prospering.

Social media are being studied in a range of health-risk behaviors, such as disordered eating (Mabe, Forney, & Keel, 2014), depression (Lin et al., 2016) or risky sexual behaviors (Broaddus et al., 2015). The first studies on *alcohol-related* social media effects appeared around 2010 (e.g., Litt & Stock, 2011; Moreno, Briner, Williams, Walker, & Christakis, 2009), and since then, it has become increasingly clear that social media can play a role in young individuals' alcohol use. Social media have become routinely integrated in the drinking practices of some individuals (Hebden et al., 2015; Hendriks, Gebhardt, & van den Putte, 2017; Niland et al., 2014), but several researchers have demonstrated that both exposure to others' alcohol-related references and self-sharing these references can affect alcohol consumption

over time (D'Angelo, Kerr, & Moreno, 2014; Geusens & Beullens, 2017b, 2019; Huang, Soto, Fujimoto, & Valente, 2014; Tucker, Miles, & D'Amico, 2013).

The present study adds to existing knowledge in at least three ways. First, the study substantially extends prior research by examining the associations between two types of alcohol-related social media use longitudinally. On one hand, individuals can *self-share* alcohol-related content, which refers to the act of a social media user posting messages or pictures via a social media platform (e.g., writing a tweet or sharing a picture on Instagram). On the other hand, individuals can be *exposed* to the alcohol-related content of others when they encounter another user's messages or pictures. Using three time points at one-year intervals, this study captures the changing role of social media in young people's lives as they transition out of adolescence and into emerging adulthood.

Second, considering that the exposure and self-sharing pathways of alcohol-related social media effects have previously been demonstrated to be intertwined (Geusens & Beullens, 2018, 2019; Geusens, Bigman-Galimore, & Beullens, 2019), we combine an interdependent social media effects approach with Slater's (2007) reinforcing spirals model to be the first to test a triple spiral between self-sharing and exposure, self-sharing and drinking behavior, and exposure and drinking behavior. Prior research has pointed toward the existence of a reciprocal relationship between sharing and drinking (Geusens & Beullens, 2017b), but this has not yet been expanded to include exposure to the alcohol references of others.

Finally, existing longitudinal studies have focused on *between*-person effects or how scoring above or below the *group mean* can affect an outcome (D'Angelo et al., 2014; Geusens & Beullens, 2017b, 2019; Huang et al., 2014; Moreno, Kacvinsky, Pumper, Wachowski, & Whitehill, 2013; Tucker et al., 2013). In contrast, *within*-person effects measure how scoring above or below one's own *personal standard* can affect an outcome (Hamaker, Kuiper, & Grasman, 2015). Unfortunately, within-person effects are not captured by traditional statistical

techniques, such as multiple regression or cross-lagged path analysis. However, failing to disentangle within-person from between-person effects may jeopardize the accuracy of our conclusions (Hamaker et al., 2015). Ergo, the third contribution of this study is to represent both within-level and between-level alcohol-related social media effects more accurately using a random intercepts cross-lagged panel model (RI-CLPM) (Hamaker et al., 2015).

An Interdependent Social Media Effects Approach

Geusens and Beullens (2017a, 2018, 2019) were the first to demonstrate the importance of adopting an interdependent social media effects approach in alcohol-related social media effects research. They argue that self-sharing and exposure pathways should be studied as two side-by-side and interdependent processes to fully understand the complexity of media environments in which users are *simultaneously* affected by external influences (via exposure to others' messages and pictures) and internal influences (via self-sharing their own messages and pictures). On one hand, via the self-sharing pathway, message senders can inadvertently affect *their own* cognitions, emotions, attitudes, and behaviors (Bem, 1972; Gonzales & Hancock, 2008; Valkenburg, 2017; Walther, 1996). Gonzales and Hancock's (2008) "identity shift" argues that when individuals communicate in a computer-mediated environment in which they are identifiable and perceive that they have an audience, such as social media, they can internalize their online self-presentations. Their self-presentations can become normative, and communicators are expected to alter their real-world behavior to be in line with their previously communicated self-presentations (Gonzales & Hancock, 2008).

On the other hand, when individuals share alcohol references on social media, they are not the only ones who engage with them, nor are they the only ones affected by them. Most young individuals encounter alcohol-related content on social media several times per month, and nearly half of them are exposed to these messages weekly or almost daily (Erevik, Torsheim, Andreassen, Vedaa, & Pallesen, 2017). Content analyses indicate that this online alcohol-

related content predominantly shows alcohol use in a positive context: people are laughing in the pictures or positive descriptors are used in textual references (Beullens & Schepers, 2013; Hendriks, van den Putte, Gebhardt, & Moreno, 2018). Less than 5% of all pictures and status updates refer to alcohol use in a negative way. This hyper-visibility of positive alcohol references on social media can normalize (heavy) drinking behavior and reinforce the perception that alcohol consumption is commonplace (Niland et al., 2014). Social norms theory posits that social behavior, such as alcohol consumption, is determined by perceptions of others' engagement in this behavior (Berkowitz, 2004; Perkins & Berkowitz, 1986). These social perceptions are in turn guided by what individuals observe. When social media are saturated with both subtle and obvious alcohol references, young individuals are likely to overestimate the prevalence and approval of actual (heavy) peer drinking behavior. This misperception is expected to put pressure on young individuals to adapt their drinking behavior to be in line with the perceived norm (Berkowitz, 2004). This is the exposure pathway of alcohol-related social media effects.

Building on these theories, Geusens and colleagues (Geusens & Beullens, 2018; Geusens et al., 2019) demonstrated that the exposure and self-sharing pathways of alcohol-related social media use are simultaneously, but differently, related to young people's drinking behavior, and over time, exposure to the alcohol references of peers is only associated with an increase in positive alcohol-related attitudes if individuals self-share alcohol references as well (Geusens & Beullens, 2019). Moreover, several scholars have demonstrated that alcohol-related communication on social media has its roots in offline drinking behavior and in perceptions of friends' alcohol-related online communication (Geusens & Beullens, 2017b, 2017a; Hebden et al., 2015; Hendriks et al., 2017, 2018; Niland et al., 2014): individuals share alcohol references on social media because they are consuming alcohol, but they only do so when their friends are also sharing alcohol-related content. Simultaneously, they consume more alcohol because

they are sharing alcohol references (D'Angelo et al., 2014; Geusens & Beullens, 2017b, 2019; Moreno et al., 2013), and the association between sharing and drinking appears to be reciprocal (Geusens & Beullens, 2017b). However, several questions about the nature of alcohol-related social media effects have not yet been answered.

Toward a Triple Reinforcing Spiral

Slater's (2007) reinforcing spirals model proposes that media selectivity and media effects can form a mutually reinforcing process that moves forward in time, creating a spiral of cumulative effects. This means that individuals often select certain media because this content is in line with certain behavioral or attitudinal predispositions (= media selectivity), and this media usage in turn reinforces those behaviors and cognitions (= media effect). A basic premise of the reinforcing spirals model is that specific patterns of media use are simultaneously an outcome and a predictor in many social processes, creating a dynamic to maintain and strengthen social identities, attitudes, and behaviors (Slater, 2007). The reinforcing spirals model is widely applied in media effects research, including studies demonstrating reinforcing spirals between online political discussions and political polarization (Hutchens, Hmielowski, & Beam, 2019), between watching music television channels and smoking behavior (Slater & Hayes, 2010), or between substance use-related media exposure and alcohol consumption (Tucker et al., 2013). In line with the theoretical premises of the reinforcing spirals model, these studies find that individuals are more likely to select media outlets that are in line with their existing attitudes and behaviors, and by using these media, their attitudes and behaviors are reinforced.

Building on this line of research, it becomes clear that media outcomes and media use should not be studied separately, and that the transactionality of the association between alcohol-related social media use and drinking behavior should be examined to fully understand the role of social media in young people's drinking behavior. To date, most longitudinal studies

examine unidirectional relationships from alcohol-related social media use toward drinking behavior (D'Angelo et al., 2014; Geusens & Beullens, 2019; Huang et al., 2014; Moreno et al., 2013). These studies demonstrate that both self-sharing alcohol references and exposure to alcohol references from others can predict alcohol consumption over time, but they say little about the transactionality of these relationships. When studying alcohol-related social media effects, three potential transactional relationships can be hypothesized due to the interactive nature of social media: a self-sharing/drinking spiral, a self-sharing/exposure spiral, and an exposure/drinking spiral.

First, the relationship between sharing alcohol references and drinking behavior has previously been studied from both directions (D'Angelo et al., 2014; Geusens & Beullens, 2017a; van Hoof, Bekkers, & Van Vuuren, 2014), and one study has already hinted at the existence of a self-sharing/drinking spiral (Geusens & Beullens, 2017b). This study modeled a reciprocal relationship between self-sharing alcohol references and drinking behavior and demonstrated that individuals share alcohol references more often when they engage in heavy drinking behavior, and by sharing these references, they also reinforce and intensify this drinking behavior over time (Geusens & Beullens, 2017b). However, the study was limited to only two time points, which makes it impossible to assess whether this relation is actually mutually reinforcing in nature, whereby individuals engage in continued or increased alcohol-related social media use and maintained or increased drinking behavior. Expanding this line of research, our first hypothesis is as follows:

H1: Self-sharing alcohol references on social media (a) predicts and (b) is simultaneously predicted by drinking behavior over time.

Second, it is important to keep in mind that respondents are also part of the friendship group that is influencing them: Just as they are influenced by their friends, they simultaneously influence others to share alcohol references (or not). In an online context, individuals adapt

their self-presentation to what they believe their audience expects of them, construct their online selves in relation to what their peers are doing, and adjust their self-presentation to resemble that of their peers (Manago, Graham, Greenfield, & Salimkhan, 2008; Utz, 2011; Walther, 1996). For instance, Geusens and Beullens (2017a) demonstrated that individuals only share alcohol references on social media if their friends do so as well. Theoretically, the hyperpersonal model of computer-mediated communication hypothesizes that there are feedback loops between communicators and receivers of computer-mediated communication (Walther, 1996). In other words, peers are expected to influence *each other*, which potentially results in an exposure/self-sharing spiral, whereby a peer group's sharing behaviors (and consequently respondents' sharing behaviors *and* exposure) are expected to move in similar patterns. Therefore, we propose that:

H2: Self-sharing alcohol references on social media (a) predicts and (b) is simultaneously predicted by exposure to friends' alcohol references on social media over time

Third, mutual influence in friendship groups has also been evidenced in drinking behavior itself. Friends' alcohol consumption is one of the most robust predictors of young people's drinking behavior, as alcohol consumption is a group behavior, and individuals' drinking patterns homogenize over time (Burk, van der Vorst, Kerr, & Stattin, 2012). Countless studies have demonstrated that young people both select friends with similar drinking patterns, and are socialized to behave more like their friends (see Leung, Toumbourou, & Hemphill, 2014; or Montgomery et al., 2020 for reviews). We can extend this line of research on homogenizing drinking patterns in offline friendships to build the argument that a reinforcing spiral between exposure to alcohol references and drinking behavior likely exists on social media as well. A large part of an individual's online social network are their offline friends and peers (Ellison & Boyd, 2013), and it is expected that there are similarities in online alcohol-related sharing patterns within friendship groups (hypothesis 2, Geusens & Beullens, 2017a). Thus, we can

expect that individuals are exposed to peers on social media with drinking and sharing patterns that are similar to the individual in question. In addition, (heavy) drinking individuals may also actively seek out alcohol-related pages and groups to follow. In turn, exposure to these alcohol references can reinforce their own drinking behavior, as it has previously been demonstrated that exposure to other's alcohol-related social media references is associated to individuals' alcohol-related cognitions and behaviors (Geusens & Beullens, 2018; Litt & Stock, 2011; Tucker et al., 2013). This potentially results in an exposure/drinking spiral, hypothesized as follows:

H3: Exposure to friends' alcohol references on social media (a) predicts and (b) is simultaneously predicted by drinking behavior over time.

Taken together, the mutual influence within friendship groups creates the need for a more elaborate spiral of alcohol-related social media effects than the one proposed in Slater's (2007) reinforcing spirals model. Specifically, we argue for the possibility of the existence of a triple spiral of alcohol-related social media effects, with three distinct spirals operating simultaneously (see Figure 1). In this triple spiral, it is not only necessary to assess whether self-sharing and drinking behavior affect each other simultaneously over time (self-sharing/drinking spiral) but also whether a reinforcing spiral exists between exposure to friends' shared content and the individual's own self-sharing (self-sharing/exposure spiral) as well as between exposure and drinking behavior (drinking/exposure spiral). This is expected to create the most ecologically valid representation of alcohol-related social media effects.

These hypotheses will be tested among a sample of late adolescents who have reached the Belgian legal drinking age¹ and are on the verge of transitioning into emerging adulthood (age 16–20 at baseline) using a three-wave panel study with one-year intervals (2015–2017).

¹ In Belgium, the legal age to buy alcohol and to enter a dancing or pub without an adult present is 16, but the average age of onset is 14 and a half (Rosiers, De Paepe, Geirnaert, & Van Damme, 2019).

Adolescence is the period in life when individuals are most likely to start experimenting with alcohol, but it is typically during emerging adulthood—from approximately 18 to 25 years of age or from graduating high school to graduating college (Arnett, 2013)—that drinking behavior escalates (Arnett, 2013; Rosiers, Coghe, De Paepe, Geirnaert, & Van Damme, 2018; Van Damme et al., 2018). As adolescents transition into emerging adulthood, they are expected to react differently to risk and social situations. Whereas adolescents' alcohol consumption and risk taking is more *socially reactive*, emerging adults are more likely to make the *conscious decision* to take risks to obtain a broad range of life experiences (Arnett, 2013). Therefore, it is crucial to capture the changing role of social media in young people's alcohol consumption as they transition through developmental stages to obtain a nuanced understanding of how alcohol-related social media effects operate.

[FIGURE 1 ABOUT HERE]

Disentangling Between-Person From Within-Person Effects

When arguing the existence of a triple spiral of alcohol-related social media effects, it is assumed that when an individual uses more alcohol-related social media, they will subsequently consume more alcohol, and vice versa. Thus, alcohol-related social media effects pertain to a process that takes place at the within-person level. To test our research hypotheses, we need to separate relationships at the within-person level from relationships at the between-person level (Hamaker et al., 2015). Within-person level effects assess how scoring above or below an individual's personal standard can affect an outcome, whereas between-person level effects are concerned with how scoring above or below the group mean can affect an outcome (Hamaker et al., 2015). Traditional longitudinal techniques, such as structural equation modeling and cross-lagged path modeling, account for temporal stability through the inclusion of autoregressive parameters but implicitly assume that all individuals vary over time around the same mean (Hamaker et al., 2015).

Very recently, new statistical techniques, such as random intercept cross-lagged panel modeling (RI-CLPM, Hamaker et al., 2015), have been developed to disentangle effects at the within- and between-person levels. By including a random intercept, RI-CLPM accounts for both temporal stability and time-invariant, trait-like stability. This is important because most attitudes, emotions, cognitions, and behaviors are to some extent characterized by stable differences between individuals (Hamaker et al., 2015). Moreover, it has been argued that when these within- and between-person level patterns are not disentangled, scholars may come to the wrong conclusions regarding the degree and kind of relationships that are being studied (Kievit, Frankenhuis, Waldorp, & Borsboom, 2013). Specifically, Kievit and colleagues argued that associations that exist at the inter-individual level do not necessarily generalize to the level of the individual, and findings at the group-level may not be generalizable to subgroups or individuals. Moreover, in about 2% of all cases, the statistical relationship observed at the group-level is reversed when examined at the subgroup or individual level (Kievit et al., 2013; Simpson, 1951). This has been called “Simpson’s paradox.” One recent study employed RI-CLPM to disentangle the relationship between violent media use and attention deficit hyperactivity disorder (ADHD)-related behaviors (Beyens, Piotrowski, & Valkenburg, 2018). They demonstrated that there are indeed differences between the between- and within-person level relationships, and the associations between ADHD-related behaviors and violent media use were explained by within-person variation over time rather than more stable between-person differences (Beyens et al., 2018). Thus, the need to disentangle between-person from within-person level effects becomes clear, wherefore this study will analyze the hypothesized triple spiral of alcohol-related social media effects using RI-CLPM.

Method

Sample

The data of the present study are part of the FLAMES research project (Flemish Alcohol and Media Survey, Geusens & Beullens, 2017b, 2017a, 2018, 2019)² and was approved by the ethical committee of the authors' university. A random sample of 50 schools was selected from the official list of all secondary schools in Flanders, Belgium in spring 2015 (T1, baseline measurement). School principals were sent recruitment emails containing the details of the study procedures, which were followed by a personal call. All pupils in the selected class groups of the third cycle of secondary education (5th, 6th, and 7th years, age 16–20) were invited to participate in a study on leisure activities, such as media use and going out behavior. A teacher and research assistant were present during the data collection, and potential respondents were asked to complete a paper-and-pencil questionnaire during school time. The research assistant explained the procedures, assured the confidentiality of the data, and distributed and collected the surveys. In total, 3558 adolescents completed the questionnaire, of whom 3515 were between the ages of 16 and 20.

The 2832 respondents who provided us with their contact details were contacted again one year later (T2, follow-up measurement 1) and two years later (T3, follow-up measurement 2). They were sent a personalized link to a web survey via email and/or regular post and were asked to fill out the new survey online. In total, 1016 respondents participated at T2 and 901 respondents participated at T3. Respondents were retained if they completed both follow-up

² The FLAMES research project uses data from a large survey containing 83 questions, including demographics, alcohol-related variables (e.g., consumption and attitudes), personality structures, school-related questions, social media variables, and questions relating to television and gaming behavior. Some variables in this dataset have already been analyzed in prior publications on alcohol-related social media effects (Geusens & Beullens, 2017b, 2017a, 2018, 2019). The present study adds to these publications by using three waves of data, focusing on reinforcing spirals between exposure, self-sharing, and drinking behavior, and disentangling between-person from within-person level associations.

measurements and were between 16 and 20 years of age at T1, resulting in a sample of 596 respondents.

A multivariate analysis of variance (MANOVA) using Pillai's trace was used to examine the differences between those who participated in all three waves, in two of the three waves, and in only one wave. This demonstrated that there were significant differences between those who participated in only one wave, two waves, or all three waves ($V=.07$, $F[18,10479]=13.13$, $p<.001$, $\eta_p^2=.02$). Specifically, follow-up univariate analyses demonstrated that boys were less likely to participate in any of the follow-up studies, those with high sensation seeking were less likely to participate in all three waves, and younger respondents were more likely to participate in the follow-up studies, but there were no age differences when comparing those who only participated in one of the follow-up measurements versus both. Respondents who only participated in the first wave shared more alcohol references than those participating in the follow-up waves, but again, there were no differences regarding the number of follow-up waves they participated in. Participants who participated in all three waves reported marginally less exposure to alcohol references than those who only participated in the first wave ($p=.05$), but no other differences regarding the exposure frequency were observed. Finally, there were no significant differences in baseline drinking behavior between follow-up responders, partial follow-up responders, and non-follow-up responders.

On average, the adolescents in our sample were 17 years old at T1, 18 years old at T2, and 19 years old at T3. Girls were overrepresented (65.6% females), although gender distributions were equal in the total sample at baseline (49.3% females). At Wave 2, the majority of our sample had started a college education (58.7%), while a minority was still in high school (37.6%), working or looking for work (2.5%), or doing something else (1.2%, e.g., a stay-at-home parent). At the final measurement, 3 respondents (0.5%) were still in high school, 92% had started a college education, 5.5% were working or looking for work, and 2% were doing

something else (most of them had just graduated high school and were still deciding what they wanted to do with their lives).

Measures

Self-sharing alcohol references on social media was measured with a scale adapted from Beullens and Vandebosch (2016). Respondents were asked how often they (1) privately and (2) publicly shared the following items on any social medium: (a) photos or video clips or (b) textual updates referring to (I) going out³, (II) alcohol use, or (III) being drunk. Private sharing was defined as “references shared with a limited amount of people, e.g., through communication via direct messaging, private groups, or group chats.” Responses ranged from 0 (never) to 6 (several times a day). Factor analysis indicated that the twelve items loaded onto one scale with good internal reliability at all three waves (eigenvalue_{wave1}=5.71, explained variance_{wave1}=47.56, $\alpha_{\text{wave1}}=.89$; eigenvalue_{wave2}=6.87, explained variance_{wave2}=57.28, $\alpha_{\text{wave2}}=.92$; eigenvalue_{wave3}=7.31, explained variance_{wave3}=60.92, $\alpha_{\text{wave3}}=.94$).

Exposure to alcohol references on social media used the same scale as the self-sharing measure, but respondents were asked to indicate how often they saw these items (1) on social media in general and (2) shared by their friends (eigenvalue_{wave1}=6.28, explained variance_{wave1}=52.35, $\alpha_{\text{wave1}}=.91$; eigenvalue_{wave2}=6.42, explained variance_{wave2}=53.48, $\alpha_{\text{wave2}}=.92$; eigenvalue_{wave3}=7.08, explained variance_{wave3}=58.96, $\alpha_{\text{wave3}}=.93$).

Alcohol consumption was measured with the “consumption” subscale of the alcohol use disorders identification test (AUDIT-C; Saunders, Aasland, Babor, de la Fuente, & Grant, 1993). Individuals were asked to indicate how frequently they consume alcohol, from 0 (never) to 4 (four or more week times a week); how many standard drinks they have on a typical drinking day, from 0 (less than 2) to 4 (10 or more); and how often they have six or more

³ Prior research in the population under consideration has shown that going out behavior is intrinsically linked to alcohol consumption in the minds of individuals (Rosiers, 2019; Van Damme et al., 2018). In the language in which the survey was administered (Dutch), “going out” (*uitgaan*) connotes partying and going to the pub to drink.

standard drinks on one occasion, from 0 (never) to 4 (daily or almost daily). Factor analysis indicated that the three items loaded onto one scale with good internal reliability at all three waves (eigenvalue_{wave1}=2.08, explained variance_{wave1}=69.37, $\alpha_{\text{wave1}}=.77$; eigenvalue_{wave2}=2.22, explained variance_{wave2}=73.97, $\alpha_{\text{wave2}}=.82$; eigenvalue_{wave3}=2.24, explained variance_{wave3}=74.73, $\alpha_{\text{wave3}}=.82$).

Control variables were gender (0 [male], 1 [female]), age (open question), frequency of general Facebook use (0 [never] through 6 [several times per day]), and sensation seeking, which was measured with the eight-item brief sensation seeking scale (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002). All control variables were measured at baseline. These variables were controlled for as prior research has indicated that older adolescents, males, and high sensation seekers are each more likely to drink more alcohol (Hittner & Swickert, 2006; Rosiers et al., 2018). Factor analysis indicated that all 8 items of the sensation seeking scale loaded onto one factor (eigenvalue=4.84, explained variance=60.44, $\alpha=.84$).

Analyses

SPSS version 26 was used for the preliminary statistics. After conducting the factor analyses, composite scores were computed for all variables, and descriptive statistics and intra-class correlation analyses were conducted. The hypothesized model was then tested using an autoregressive random-intercept cross-lagged path model in Mplus (version 8.0; Hamaker, 2018; Hamaker et al., 2015). The RI-CLPM was specified according to the procedure outlined by Hamaker and colleagues (Hamaker, 2018; Hamaker et al., 2015). First, three new individual factors were created—the random intercepts for self-sharing, exposure, and consumption. These random intercepts contain “the variance that is due to the individual’s stable position in the sample at the between-person level”. Second, the within-person centered variables were created, and the measurement error of the variances of the items were constrained to zero. These variables contain the within-person fluctuations around an individual’s expected score

for each measurement, whereby the expected scores are based on the individual's rank-order position on the random intercept and the observed mean level structure over time. Third, the lagged effects between the within-person centered variables was estimated by regressing each variable at T2 and T3 on the variables in the preceding waves, as well as the control variables (e.g., sharing T3 was regressed on sharing T2, exposure T2, consumption T2, gender, age, and sensation seeking). Fourth, the covariances between the within-person centered variables at the first wave and between the residuals of the within-person centered variables were estimated. Finally, the correlations between the individual factors (random intercepts) and the other exogenous variables were constrained to zero. A visual representation of the RI-CLPM can be found in Figure 2. The model was estimated using the full information maximum likelihood (FIML) estimation with robust standard errors (MLR) to account for nonnormality and nonindependence of the data (Muthén & Satorra, 1995).

[FIGURE 2 ABOUT HERE]

Results

Descriptive Statistics

Respondents were heavy Facebook users at baseline, as only 2.2% never used Facebook, and 8.5% used Facebook no more than a few times per week. The majority of respondents indicated that they share alcohol references on social media (63.7% at baseline, 68.0% at T2, 72.0% at T3). On average, they share these references a few times per year, and approximately one in ten respondents share these references at least once per month (10.3% at baseline, 10.0% at T2, 13.5% at T3). In addition, less than 1% indicated that they were never exposed to alcohol references of peers. On average, they were exposed to these references approximately once per month, and 10% reported that they were exposed at least once per week (9.0% at baseline, 8.6% at T2, 12.4% at T3). Difference scores analysis indicated that nearly half our respondents increased their exposure and sharing behavior over the years (see Table 1).

[TABLE 1 ABOUT HERE]

When looking specifically at our respondents' drinking behavior, we see a decline in the number of respondents who do not consume alcohol over the years (14.8% at T1, 11.6% at T2, 10.9% at T3). Most respondents consume alcohol two to four times per month (64.5% at T1, 51.0% at T2, 50.4% at T3). Almost no one consumed alcohol more often than once per week at baseline (0.2%), but consuming alcohol several times per week steadily increased over the years (11.6% at T2, 19.4% at T3). At a typical drinking event, most respondents consumed less than four glasses of alcohol (65.7% at baseline, 74.0% at T2, 72.7% at T3). About half our sample never consumed six or more glasses of alcohol in one sitting (54.4% at T1, 48.2% at T2, 44.6% at T3), and while the amount of respondents who engaged in this heavy episodic drinking behavior a few times per year increased over the years (27.9% at T1, 34.1% at T2, 35.2% at T3), engaging in this type of drinking behavior at least once per month remained relatively stable over the years (17.7% at T1, 17.8% at T2, 20.1% at T3). Overall, difference scores indicated that one in three respondents increased their drinking behavior over the years (see Table 1). Table 2 displays the descriptive statistics and zero-order correlations.

[TABLE 2 ABOUT HERE]

Between-Person Level Analyses

The hypothesized model was tested using RI-CLPM to disentangle between-person level from within-person level effects.⁴ This model demonstrated excellent fit (RMSEA=.05, CFI=.998, TLI=.96, SRMR=.01). First, we found positive significant relationships between sharing, exposure, and consumption at the between-person level: across waves, the group of

⁴ An alternative model was run using clustering analyses to account for clustering at the school level, whereby a few relationships changed at the within-person level. In particular, when adding cluster analysis, the autoregressive relationship between alcohol consumption at baseline and at T2 was no longer significant, but instead we found a significant cross-lagged relationship between exposure to alcohol references at baseline and drinking behavior at T2 ($\beta=.14$, $p<.05$). Nevertheless, these results should be interpreted with caution, as there were identification issues with this model as we had more parameters than clusters. The effect of having more parameters than clusters has not been well-studied, but it is likely the standard errors are too small.

individuals who reported higher alcohol consumption compared to their peers in the study also reported more frequent self-sharing, and those who reported more frequent self-sharing also reported more frequent exposure, but the association between exposure and alcohol consumption was not significant (dotted lines in Figure 3).

Within-Person Level Analyses

The significant covariations between the three variables (self-sharing, exposure, and consumption) at each time point indicate that—except at baseline—within-person change (or deviation from an individuals' expected score) in self-sharing, within-person change in exposure and within-person change in consumption are associated cross-sectionally. In other words, when an individual scores above or below their own expected level of self-sharing behavior, they consonantly score above or below their own expected level of exposure and drinking behavior, and vice versa. However, these cross-sectional within-person level relationships between alcohol-related social media use and drinking behavior do not endure over time (see Figure 3). The only significant cross-lagged relationship was found between within-person deviation from one's own expected scores in alcohol consumption at T2 and deviation from one's own expected scores in exposure at T3. Individuals who consumed more alcohol than expected at T2 were also more frequently exposed to alcohol references than expected at T3. No other significant cross-lagged relationships were observed. Thus, over time there were no within-person alcohol-related social media effects, nor were there any within-person reinforcing spirals between alcohol-related social media use and drinking behavior or between exposure and self-sharing. In addition, there were no auto-regressive within-person relationships for our social media variables between baseline and T2: Neither more frequent self-sharing of alcohol-references nor more frequent exposure to alcohol references predicts sharing or exposure one year later.

[FIGURE 3 ABOUT HERE]

Discussion

It has been argued that social media have become routinely integrated in young people's drinking practices (Hebden et al., 2015; Niland et al., 2014). However, because the field of social media effects research is relatively young, many questions still need to be answered. The present study aimed to advance our understanding of alcohol-related social media effects through its unique research design. This research design yielded several new insights regarding how alcohol-related social media effects operate.

First, our results demonstrate the importance of using refined statistical techniques, such as RI-CLPM, to reach more accurate and nuanced conclusions. The results of the RI-CLPM indicate that the relationship between social media use and drinking behavior is complex and differs at the between-person and within-person levels. At the between-person level, we find that adolescents who frequently share alcohol references are also frequently exposed to alcohol references from others and consume relatively large amounts of alcohol, and vice versa. In contrast, at the within-person level, changes in alcohol-related social media use (either sharing or exposure) is not related to alcohol consumption over time. Hence, it is possible that cross-lagged relationships found in research using a traditional CLPM actually reflect the more stable traits of a specific group of individuals who frequently engage with alcohol-related social media and also consume large amounts of alcohol. This would be reflected by the positive and significant between-person level correlations in the RI-CLPM.

By the same token, the finding that we can discern positive relationships between alcohol-related social media use and drinking behavior at the group level, but not at the individual level, implies that adolescents who frequently engage with alcohol-related social media and consume large amounts of alcohol may constitute a subgroup or perhaps even a subculture. Humans are connected beings that function within social networks where they associate with similar others (Barabási, 1995; Christakis & Fowler, 2009). Within these networks, specific norms and

behaviors are consciously and unconsciously reinforced and assimilated (Christakis & Fowler, 2009). Research on alcohol consumption consistently demonstrates these network homophily effects in individuals' drinking patterns, as young people tend to affiliate with a network of similar peers, and attitudes and behaviors within these friendship networks are found to become more similar over time (Leung et al., 2014; Montgomery et al., 2020). Considering that our sample consists of older adolescents who have reached the legal drinking age, it is not unthinkable that—although specific drinking patterns are still forming—our respondents have already self-sorted into friendship networks with heavier or lighter drinking and sharing patterns at the time of the baseline measurement. For adolescents within certain friendship networks, it might be the case that the sharing of alcohol related posts on social media is an important part of their drinking culture, whereby sharing alcohol related content might simply coincide with drinking alcohol rather than the cause or consequence of this behavior. This would be in line with the finding that heavy drinkers who share intoxicated photos and messages on social media aim to construct a drinkers' image to fit in with their heavy drinking peers (Hebden et al., 2015; Niland et al., 2014). For them, alcohol references on social media are not casual representations or memories of drinking pleasures but rather constructs identifying, connecting, and reinforcing friendship group relations (Niland et al., 2014). In contrast, for more casual drinkers, online alcohol representations are more incidental (Hendriks et al., 2017). A network effect resulting in subgroups of heavy drinking and sharing friendship networks may explain why we do not find much movement at the within-person level. Within-person analyses look at effects over and above the effect of the group, and if this is indeed a network effect or subgroup phenomenon, group level relationships are expected to be more robust than individual level relationships.

The second major finding of this study is that we did not find the expected triple spiral: our results at the within-person level do not support the hypothesis that alcohol-related social media

effects move forward in time and reinforce themselves. In fact, we did not find alcohol-related social media effects at all. This raises the question in which contexts Slater's reinforcing spirals model reflects within-person processes. When looking at other studies in different domains of media effects research that use the RI-CLPM, mixed results are found. For instance, similarly to our results, one study on cyberbullying found a stable between-person level relationship between cyberbullying victimization and perpetuation, as well as within-person covariations at specific time points, but no within-person effects over time (Erreygers, Vandebosch, Vranjes, Baillien, & De Witte, 2017). However, within the same sample, the authors did find both stable between-person level and time-varying within-person level relationships between performing and receiving online *prosocial* behavior (Erreygers et al., 2017). A study on 'cyberchondria' found a stable between-person level association between health anxiety and online health information seeking, but no cross-lagged within-person level relationships over time when studying a clinical sample (te Poel, Baumgartner, Hartmann, & Tanis, 2016). In contrast, they did find reciprocal within-person relationships between health anxiety and online health information seeking over time for a non-clinical sample (te Poel et al., 2016). Taken together, this suggests that the nature of the media effect, as well as the sample under consideration, are likely to determine whether a reinforcing spiral is found at the within-person level, or only reflects group dynamics and differences between social networks. For instance, Scharkow and Bachl (2017) have already suggested that the reinforcing spirals model may be particularly useful when studying more volatile attitudes and behaviors, untypical samples for the behavior under consideration, or more unstable contexts. When translating these propositions to the field of alcohol-related social media effects, this means that it may be useful to apply the reinforcing spirals model to samples who are in a more experimental phase of alcohol consumption, such as younger adolescents, or samples of individuals who are dealing with dramatic shifts in their social context.

Nevertheless, we did find that—except at baseline—drinking, sharing alcohol references, and exposure to alcohol references from others are cross-sectionally related at the within-person level. This means that if an individual shares more alcohol references than expected at a specific point in time, they are also more exposed to alcohol references from others at that moment and are consuming more alcohol than expected. However, as these associations are cross-sectional, the direction of the relationships remains unclear. In addition, this finding also raises the question of whether within-person level alcohol-related social media effects and the reinforcing spirals model exist over a shorter timeframe than the one-year time-lag employed in this study. To elucidate exactly how self-sharing alcohol references on social media, exposure to others' alcohol-related content, and drinking behavior are related, more longitudinal research with different time lags (e.g., one week, one month, and several months) is needed. This will help us to interpret the cross-sectional within-person level associations found in this study and establish how long potential alcohol-related social media effects last (if they are found at all). Nevertheless, even short-lived alcohol-related social media effects are not necessarily harmless. On one hand, individuals are most likely repeatedly exposed to alcohol references on social media or self-sharing such content (Erevik et al., 2017), which could repeatedly trigger elevated drinking behavior. On the other hand, the between-person level results indicate that there may be specific social networks of heavy drinking adolescents who also engage heavily with alcohol-related social media content. Following propositions of media conditionality (e.g., Valkenburg & Peter, 2013), it is possible that these individuals are also the most strongly affected by the alcohol-related social media they use.

Finally, we have studied an age group in transition, and it appears that the role of alcohol-related social media use changes over time. As mentioned above, cross-sectional within-person level relationships between alcohol-related social media use and drinking behavior exist at T2 and T3, but not at baseline. In addition, there were no autoregressive relationships of exposure

or self-sharing from baseline at T2. This appears to indicate that alcohol-related social media use transforms as adolescents transition into emerging adulthood and their social environment changes. During adolescence, sharing alcohol-related content on social media may be more experimental, which would explain why there were no stable within-person autoregressive relationships for either self-sharing or exposure. As adolescents age and transition into emerging adulthood, alcohol-related social media use may become more established in individuals' drinking practices, which would be reflected by the autoregressive associations for alcohol-related social media use between T2 and T3.

Limitations

Although the present study refines our understanding of alcohol-related social media effects by using three waves of data with one-year intervals to disentangle between-person level effects from within-person level effects, it is important to acknowledge the limitations of our research. The most important limitation of this study is the relatively large attrition rate throughout the three waves of data. At baseline, respondents were collected via their schools. All pupils of the selected class groups were invited to participate in the study and were instantly rewarded with a class-free hour while filling out the survey. Consequently, almost all invited adolescents participated in the study at baseline. In contrast, the second wave of the study was collected outside of the school environment because half of our respondents were transitioning out of secondary school. Baseline respondents were contacted up to six times to participate in the second and third waves through both email and regular mail. As a result, nearly one in two respondents who provided us with their contact details (47%) participated in at least one of the follow-up waves, which equals 37.5% of the total baseline sample (29% Wave 2, 25% Wave 3), and 17.0% participated in both waves. However, those who participated in the follow-up waves differed significantly from the non-responders, which could point to the existence of systematic nonresponse and lead to attrition bias, which may threaten the validity and

generalizability of our results. Respondents with more risky profiles (e.g., greater alcohol consumption or more frequent sharing) were less likely to participate in follow up research. Although this is common in alcohol-related research, it entails a risk of misestimating the actual strength of our relationships (Caetano, 2001; Radtke, Ostergaard, Cooke, & Scholz, 2017). Although clear evidence regarding the direction of the misestimation of the strength of these relationships is lacking, it has been cautiously argued that this type of non-response bias can lead to attenuation of the modeled relationships (Caetano, 2001). Additional longitudinal studies using different follow-up methods to retain the largest possible sample are therefore necessary to test if our conclusions hold. Following respondents via repeated classroom surveys may be a feasible alternative if respondents are not in the school transitioning phase (e.g., Trekels & Eggermont, 2017). Another option is to offer monetary incentives (Caetano, 2001).

A second limitation stems from the fact that self-report measures were used. Although self-reports are common in this line of research and generally found to be reliable (Simons, Wills, Emery, & Marks, 2015), they entail the risk that respondents misjudge their alcohol consumption and their engagement with alcohol-related social media. Third, the country in which this study was conducted has a very tolerant alcohol policy. In most countries, the minimum age to buy alcohol is 18, but in Belgium, the minimum age is 16. These differences in legal norms could potentially affect how individuals perceive and engage with alcohol. However, prior cross-cultural research comparing Belgium with the United States has demonstrated that, at least among college students, alcohol-related social media effects appear to operate similarly in different drinking cultures (Geusens et al., 2019). Nonetheless, more cross-cultural research focusing on adolescents or conducted in other parts of the world would be valuable to assess the generalizability of our findings to other samples.

Fourth, we studied a sample that was legally allowed to buy and consume alcohol. At our baseline measurement, most respondents (95%) were between the ages of 16 and 18. Although

research indicates that drinking patterns are still forming at this age (Rosiers et al., 2018), most adolescents are already consuming alcohol at this age (87% in this sample). It would be useful to replicate this study among a younger age group, as research among incoming college students in the United States has previously indicated that alcohol-related communication on social media prior to a new life phase (e.g., reaching the legal drinking age) can be a predictor of alcohol consumption once this new life phase is reached (D'Angelo et al., 2014).

Fifth, our social media measures did not differentiate between platforms. Not all social media are equal, and social media platforms are distinguished from one another by their specific attributes. These structural dimensions allow users to engage with a social medium in a particular way and constrains them from other usage practices (Comunello, Mulargia, & Parisi, 2016). In addition, media ideologies shape usage norms and practices by enforcing platform-specific etiquette requirements (Comunello et al., 2016). Thus, different social media platforms allow for different kinds of self-expression and content-sharing, and individuals are aware of the structural and ideological differences between social media. Consequently, differences between social media platforms can result in differences in the character and strength of media effects. Incorporating platform-specific attributes in future research is expected to refine the accuracy of social media effects research by identifying specific features and attributes that affect individuals more strongly than others.

Finally, we defined alcohol-related content as visual and textual references to going out behavior, alcohol, and intoxication, without differentiating between different types of user-generated and commercial content. User-generated content that an individual encounters can originate from a range of peers, from close friends to distant acquaintances. Social comparison theory states that an opinion is more likely to be adopted when it is presented by someone similar to oneself, as well as when viewing the behavior of a proximal referent in comparison to that of a more distant referent (Festinger, 1954). Thus, it is possible that exposure to alcohol-

related content from different types of peer instigate different processes. In addition, user-generated content and commercial content can no longer be fully separated from one another on social media, and most individuals perceive alcohol advertising to be absent from social media because it is so deeply embedded in their everyday social media use (Niland, McCreanor, Lyons, & Griffin, 2017). Nevertheless, it would be useful to try and separate these types of social media content in the future.

Conclusion

This study advanced our understanding of alcohol-related social media effects by examining the associations between two types of alcohol-related social media use (exposure and self-sharing) longitudinally. Using three time points at one-year intervals, this study captured the changing role of social media in young people's lives as they transition out of adolescence and into emerging adulthood. Thereby, an interdependent social media effects approach was combined with Slater's (2007) reinforcing spirals model to be the first to test a triple spiral between self-sharing and exposure, self-sharing and drinking behavior, and exposure and drinking behavior while simultaneously disentangling within-person level effects from between-person level effects. This novel approach demonstrated that there are between-person differences in how alcohol consumption and alcohol-related social media are associated, but no within-person effects were found.

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Table 1. *Changes in social media use and drinking behavior across the waves.*

	% decrease	% stable	% increase
Alcohol consumption			
Baseline → T2	34.6	31.6	33.8
T2 → T3	24.7	38.3	37.0
Sharing of alcohol references			
Baseline → T2	34.4	25.0	40.6
T2 → T3	30.5	23.8	45.7
Exposure to alcohol references			
Baseline → T2	52.5	5.4	42.1
T2 → T3	42.3	4.2	53.5

Table 2. Zero-order correlations and descriptive statistics.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Consumption baseline												
2. Consumption T2	.73***											
3. Consumption T3	.65***	.79***										
4. Exposure baseline	.25***	.27***	.18***									
5. Exposure T2	.23***	.34***	.27***	.51***								
6. Exposure T3	.26***	.33***	.36***	.41***	.59***							
7. Sharing baseline	.39***	.35***	.30***	.43***	.33***	.27***						
8. Sharing T2	.37***	.50***	.41***	.37***	.54***	.39***	.48***					
9. Sharing T3	.30***	.39***	.41***	.29***	.40***	.59***	.32***	.52***				
10. Sensation seeking	.38***	.31***	.30***	.20***	.15***	.18***	.28***	.27***	.20***			
11. Age at baseline	.12**	.05	-.03	.14***	.09*	.04	.07	.06	.01	.00		
12. General Facebook use	.18***	.18***	.14***	.21***	.15***	.14***	.16***	.13***	.09*	.02	.06	
13. Gender	-.17***	-.16***	-.19***	-.03	-.05	-.05	.10*	.01	-.03	.07	-.04	.10*
M	1.12	1.10	1.20	1.70	1.62	1.75	.37	.41	.52	3.02	16.96	5.41
(SD)	(.79)	(.80)	(.85)	(.90)	(.90)	(.99)	(.48)	(.55)	(.66)	(.74)	(.78)	(1.18)

Note. *** p<.001, ** p<.01, * p<.05

Figure 1. Three reinforcing spirals of alcohol-related social media effects.

Figure 2. Visual representation of triple spiral random intercept cross-lagged panel model (RI-CLPM).

Figure 3. Standardized RI-CLPM for the longitudinal associations between alcohol-related social media use and drinking behavior across three waves.