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Hanging Out With the Right Crowd: Peer Influence on Risk-Taking Behavior in Adolescence

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Peer influence plays a key role in the increase of risk-taking behavior during adolescence. However, its underlying processes are not fully understood. This study examined the effects of social norms, conveyed through peer advice, on risk-taking behavior in 15- to 17-year-old adolescents (N = 76). Participants played a card-guessing task alone and with online peer advice. Results showed that risk-taking increased in the presence of peers. The results further showed that adolescents took into account the uncertainty associated with gambles, as well as the social norms conveyed by peers. Our findings suggest that peers are most influential in uncertain situations and demonstrate the value of a social norms approach in examining the processes underlying peer effects.

If all your friends jumped off a cliff, then would you? Parents who worry about the negative influence of peers frequently pose this question to their adolescent son or daughter and expect the answer to be "no." It is not surprising that parents are concerned about the influence of friends on their child's engagement in risk-taking behaviors. The rates of these behaviors, such as substance abuse, risky driving, or gambling, increase in adolescence (Boyer, 2006). In addition, risk-taking behavior is more likely to occur when in the presence of peers than when alone (Albert, Chein, & Steinberg, 2013; Dishion & Tipsord, 2011).

A large body of literature has consistently demonstrated that peers increase risk-taking behavior in the laboratory (Chein, Albert, O'Brien, Uckert, & Steinberg, 2011; Gardner & Steinberg, 2005; Haddad, Harrison, Norman, & Lau, 2014; Knoll, Magis-Weinberg, Speekenbrink, & Blakemore, 2015; Munoz Centifanti, Modecki, MacLellan, & Gowling, 2016; Simons-Morton et al., 2014; Smith, Chein, & Steinberg, 2014; but see Lourenco et al., 2015) and in daily life (Simons-Morton et al., 2011). Even though these results suggest that peer influence can be considered a risk factor in adolescence, it may also promote cautious behavior (Brown, Bakken, Ameringer, & Mahon, 2008). The process underlying these peer effects on risk-taking behavior is not yet fully understood.

This study employed a social norms perspective to examine the positive and negative effects of peer advice on gambling behavior. Social norms can be defined as expectations about appropriate behavior endorsed by a group (reviewed in McDonald & Crandall, 2015). Through social norms, peers can potentially encourage risky as well as risk-averse behavior. Using this novel approach in an experimental task, we set out to investigate how social norms conveyed through different types of peer advice relate to risk-taking behavior during adolescence.

Peer Effects: The Underlying Process

One hypothesis about the process underlying peer effects is that peer presence negatively influences adolescents' cognitive control functions by increasing impulsivity during decision making (O'Brien, Albert, Chein, & Steinberg, 2011; Weigard, Chein, Albert, Smith, & Steinberg, 2014). Delay discounting is one form of impulsivity and can be described as the tendency to exhibit impatience when given a choice between an immediate small reward versus a larger but delayed reward (Romer, 2010). Recent experimental studies investigating delay discounting showed that the presence of peers increased young adults' (age 18–22 years) preference for immediate rewards over larger delayed rewards (O'Brien et al., 2011; Weigard et al., 2014). Another study showed that, after

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viewing impulsive decisions of age-matched peers, young adults (age 18–25 years) had a preference for smaller, earlier payments as well (Gilman, Curran, Calderon, Stoeckel, & Evins, 2014).

A second hypothesis states that peer presence either "primes" the social–emotional system for reward opportunities or influences both the reward and control systems (Albert et al., 2013; Chein et al., 2011; Smith, Steinberg, Strang, & Chein, 2015). In line with this second hypothesis, the presence of peers may increase the subjective value of rewards, for example by making rewards more arousing, and thereby also increase the preference for a risky choice over a safe alternative (Albert et al., 2013). These aspects of adolescent risk-taking have been well captured in developmental dual process and imbalance models (Galván, 2010; Somerville, Jones, & Casey, 2010; Steinberg et al., 2008), which propose that adolescents show heightened social–emotional sensitivity in early adolescence and protract the development of cognitive control in late adolescence. Peer effects could then be a factor that tips the balance to less control and more reward sensitivity, leading to risk-taking behavior.

Studies that employed a video driving game have shown that both passive (friends observing performance; Chein et al., 2011) and active (friends calling out advice; Gardner & Steinberg, 2005) peer influence resulted in riskier driving in adolescents (age 13–18 years) but not in adults. The impact of active feedback is generally larger than passive observation (Munoz Centifanti et al., 2016), but this seems to be dependent on task specifics (e.g., Haddad et al., 2014). Taken together, there is evidence from experimental studies showing that adolescents are sensitive to both passive peer presence and active peer influence when taking risks.

A Social Norms Perspective on Peer Effects

Another useful framework for understanding peer influence on risk-taking behavior is the *social norms perspective* (Bandura, 1986; Cialdini & Trost, 1998; Van Hoorn, Van Dijk, Meuwese, Rieffe, & Crone, 2016). Social norms specify which social behaviors are accepted in the peer context and whether such behaviors will elicit approval from peers (Berger, 2008; McDonald & Crandall, 2015). These norms may not always encourage an increase in risk-taking, but may instead also promote a decrease in risk-taking behavior (Brown et al., 2008).

In general, adults are more likely to act according to social norms when a situation is novel, ambiguous, or uncertain (Cialdini & Trost, 1998). Given that social acceptance is important during adolescence (Sebastian, Viding, Williams, & Blakemore, 2010), individuals may be especially susceptible to social norms during this time—and even more so in situations of uncertainty. One previous study showed increased risk-taking in 15- to 17-year-olds as a result of peer *presence* in a probabilistic gambling task (PGT), but only for gambles with a lower gain–loss probability (Smith et al., 2014).

Naturalistic studies that employed the social norms perspective have shown that there is variability in adolescent risky driving outcomes with peer passengers that may be dependent on how these peers behave (Simons-Morton et al., 2011, 2014). The effect of peer presence on teenage males' (age 16–18 years) simulated driving behavior was investigated by comparing driving alone to driving in the presence of a risk-accepting peer and a risk-averse peer (Simons-Morton et al., 2014). Evidence for a general effect of peer presence was found, which is consistent with prior studies showing that driving with a peer leads to more risky driving (e.g., Allen & Brown, 2008; Pradhan et al., 2014). However, driving with a risk-accepting peer increased risky driving more than driving in the presence of a risk-averse peer. These findings show that social norms influence risk-taking behavior, and sensitivity to these norms may explain variability in risk-taking behavior. However, to date, it is unknown how social norms conveyed by peer advice and uncertainty interact in risky decision making during adolescence.

The Present Study

In this study, we tested the effects of peer advice on risk-taking behavior under varying uncertainty conditions. This novel approach combining social norms with experimental methods allowed us to manipulate different advice types that either enhanced or reduced risk-taking while we varied the uncertainty associated with the outcomes of the risk. We tested the hypothesis that adolescents are specifically sensitive to peer advice when outcomes are uncertain. For this purpose, we designed a card-guessing task to investigate risk-taking behavior, referred to as Guess Gambling Game (GGG) (similar to Critchley, Mathias, & Dolan, 2001; Delgado, Miller, Inati, & Phelps, 2005; Smith et al., 2015).

On each trial, the participant was shown a playing card and was asked to guess whether a subsequently drawn card would have a higher or lower value than the current card. Then, participants bet a variable number of poker chips on whether they guessed correctly. Risk-taking behavior was operationalized in this task as the number of chips bet. The GGG was played alone and in the presence of anonymous online peers. Participants were told that the online peer watched their decision and would give them advice on how many chips to bet. This peer advice was experimentally controlled to be *low bet* advice (bet 1 or 2 chips), *medium bet* advice (bet 4 or 6 chips), or *high bet* advice (bet 8 or 9 chips). Because the task consisted of a guess and a gamble, we were able to disentangle the effects of peers on guessing behavior (i.e., the ability to make a rational choice in line with the card probability) and gambling behavior (i.e., risk-taking behavior).

Our first analysis tested the hypothesis that guessing behavior would show a dichotomous pattern in both the alone and peer advice conditions, in which participants would select *higher* for cards 1–4, *lower* for cards 6–9, and would have no preference for card 5. In this card condition, we expected a 50% probability of *higher* (Critchley et al., 2001). This pattern is in accordance with previous work that illustrates that adolescents, like children and adults, can make accurate decisions about probabilities (Reyna & Farley, 2006; Van Duijvenvoorde & Crone, 2013; Van Leijenhorst et al., 2010).

Second, we examined the influence of the type of peer advice on gambling behavior. Although we expected to find a general increase in betting behavior with peers present (Munoz Centifanti et al., 2016; O'Brien et al., 2011; Smith et al., 2014; Weigard et al., 2014), based on the social norms conveyed in peer advice we predicted a differentiated pattern (Simons-Morton et al., 2014). In line with social norms theory, we hypothesized that participants would place their bets in accordance with the advice expressed by the online peer (i.e., low bet, medium bet, or high bet) and that these effects would be largest in the most uncertain situation (Cialdini & Trost, 1998; Smith et al., 2014).

In the current study, we collected data from adolescents aged 15–17 years for several reasons. First, we wanted a comparable sample to previous studies of interest. Smith et al. (2014) studied 15- to 17-year-olds and studies from the social norms perspective used 16- to 18-year-olds because of the U.S. legal driving age (Simons-Morton et al., 2011, 2014). Across the literature, there is some inconsistency with regard to the definitions of adolescence. In particular, those aged 18+ are alternately called (late) adolescents, youths, or young adults. To avoid confusion, our sample did not include 18-year-olds. Fifteen-year-olds were included in this study for practical reasons as well, given that we included participants from two consecutive school years, which included 15- to 16-year-olds and 16- to 17-year-olds. Second, this age group is specifically interesting because neuroimaging work has shown that adolescent risk-taking behavior peaks around the age of 15–17, when the brain is particularly sensitive to rewards (e.g., Braams et al., 2015). The specific age range allowed us to test hypotheses about this age group and explore individual differences in terms of gender. A meta-analysis suggests higher rates of gambling behavior in males relative to females over the age range of 10–21 years old (Byrnes, Miller, & Schafer, 1999). Moreover, some literature points to enhanced sensitivity to peer influence in males relative to females either across all of the adolescent period (Steinberg & Monahan, 2007) or most pronounced in 13- to 15-year-olds (Sumter, Bokhorst, Steinberg, & Westenberg, 2009). Therefore, we expected males to be more influenced by the online peers than females.

METHODS

Participants

The sample consisted of 76 adolescents between the ages of 15 and 17 years ($M = 15.9$, $SD = 6$ months, range 15.0–17.1), including 44 males (58%) and 32 females (42%). Six additional participants from the original sample ($N = 82$) had to be excluded due to incomplete data. Both parental consent and participant's consent for minors were obtained from all participants. All adolescents for whom we obtained informed consent participated in the study. Participants were recruited from several consecutive years in a school that teaches secondary vocational education (Dutch school system: VMBO). We did not collect information regarding parental income or parental education level. However, participants were mostly Caucasian and the school was located in a middle-class neighborhood in the Netherlands (Knol, 2012).

To obtain an estimate of general intellectual ability, participants completed Raven's Standard Progressive Matrices (SPM) (Raven, Raven, & Court, 1998). Raven's SPM consists of 60 items, categorized in five sets (A through E) of 12 items each. Each item consists of a 2 × 3 or 3 × 3 matrix figure in which one cell is empty. Either six (sets A and B) or eight (sets C through E) pieces are displayed below the figure from which the participant has to select the one piece that completes the figure. The different sets and items within a set increase in difficulty. Based on the number of correct items, estimated IQ scores were obtained using international norms (Raven et al., 1998). Due to missing data ($N = 3$), we included the IQ scores from $N = 73$ participants in the final sample. All IQ scores from the final sample fell within the average to above average range, $M(SD) = 108.78$ (9.92); 85–125. There was no significant difference in IQ for the two genders (M_{female} $(SD) = 107.17$ (9.12) and M_{male} $(SD) = 109.84$ (10.37), $t(71) = 1.13$, $p = .264$).

Measures

We designed a computerized task with playing cards, the Guess Gambling Game, that incorporated two types of decision making: guessing behavior and gambling behavior. Trials started with one playing card that was presented face up, from a deck of cards ranging between hearts 1 (ace) to hearts 9. Subsequently, the second card was presented with the reverse side up, such that the value of this card was unknown. Participants were asked to guess whether the second card would be higher or lower than the first card. After this guess, participants placed a bet ranging from 1 to 9 chips and they found out whether they guessed correctly. If the gamble was correct, the number of chips bet was doubled and added up to the number of remaining chips to provide a final score for that trial [e.g., a bet of 8 chips following a correct guess resulted in a score of 17 (8 chips × 2 added to 1 remaining chip)]. However, when the guess was incorrect, the participant lost the chips that were placed in the bet, but kept the chips that were not bet in the trial [e.g., a bet of 8 chips following an incorrect guess resulted in a score of 1 (the chip that was not bet)].

Each trial was played with a new deck of playing cards and a new stack of 9 poker chips, such that each trial was unrelated to previous trials. The experiment consisted of 160 trials: card 5 was shown 32 times and all other cards were shown 16 times each. Participants were not informed of how many times each card would be shown. Participants first played Guess Gambling Game alone in a block of 40 trials. The next three blocks of 40 trials (120 in total) were played with an online peer, indicated by a messenger symbol in the corner of the screen. These peers were 50% female (60 trials), indicated by a pink messenger symbol, and 50% male (60 trials), indicated by a blue messenger symbol. We chose not to counterbalance the order of alone and peer advice because prior studies have shown that there can be carry over effects (Van Hoorn et al., 2016), and we aimed to create a pure baseline before introducing peer influence. Note that we did not examine possible effects of the gender of the peer, because there were too few trials to draw valid conclusions; instead we controlled for possible peer gender effects by counterbalancing male and female peers.

The fictitious online peer watched the performance on the entire trial and gave participants advice on how many chips to bet, indicated by a number next to the messenger symbol (Figure 1). We manipulated three types of betting advice: low bet (bet 1 or 2 chips), medium bet (bet 4 or 6 chips), or high bet (bet 8 or 9 chips). To maintain credibility of the advice given by peers, the advice for card 1 and 9 was always to bet 9 chips. Low, medium, and high advice was each randomly provided 32 times during the trials in which cards 2 to 8 were presented (1/3 of 96 trials).

To control for possible button press effects, half of the participants used their left index finger to guess *higher* and their right index finger to guess *lower* and the buttons were reversed for the other half of the participants.

Procedure

The study was conducted in a quiet classroom in which the task was individually administered to participants using a laptop computer. The experimenter provided standardized verbal instructions about the procedures and was present at all times to provide help with the instructions. In addition, the task was preceded by an extensive written instruction and practice trials. Participants completed three different elements during the study: first the Guess Gambling Game, then Raven's SPM, and finally the RPI questionnaire. Participants were told that their final score on the GGG was calculated by resolving the outcomes of 4 randomly selected trials at the end of the gambling task. All trials had the same probability to be included in the final score, and therefore, each trial was equally important. Participants could choose between two possible rewards: a small amount of money related to their final score (unbeknownst to the participants, the final score always corresponded to a 3 Euro reward) or a lottery ticket for a bigger reward (an iPod or 2 cinema tickets). No differences in gambling behavior or peer effects were found between participants that chose the immediate or delayed reward. Participants were debriefed about

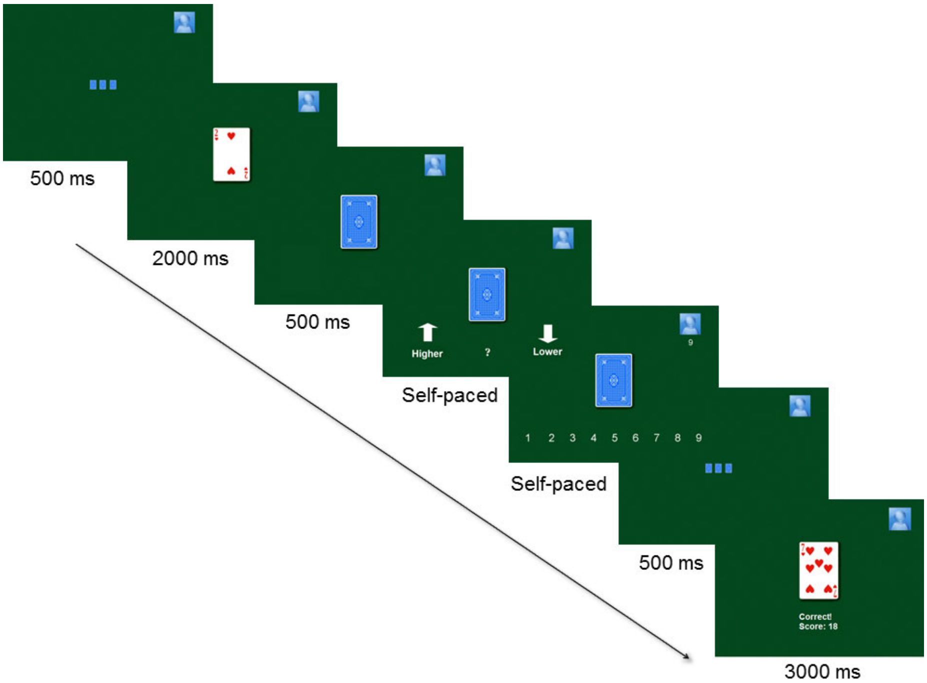

FIGURE 1 Example of a trial with peer advice in the Guess Gambling Game. Card 2 of hearts is shown while a male peer is watching, as indicated by a blue messenger symbol in the upper corner. The participant guesses that the second card will be higher than the first card. Following the guess, the online peer gives advice to place a bet of 9 chips, indicated with a number below the messenger symbol. The participant decides to follow the advice of the peer and places a bet of 9 chips. This is a correct guess, and therefore the score for this trial is $9 \times 2 = 18$ points.

the peer manipulation and goals of the study after all data had been collected.

RESULTS

Guessing Behavior

First, we examined whether participants' guessing behavior was related to the actual probability of a higher card being drawn and whether this was influenced by peer presence (i.e., whether they were playing alone or with peer advice). We expected to find a dichotomous pattern in which participants select *higher* for cards 1 to 4 and *lower* for cards 6 to 9, whereas 50% probability was expected for card 5. We submitted the percentages of higher guesses to a 2 (condition: alone, peer advice) × 9 (cards: 1 to 9) × 2 (gender: male, female) repeated-measures analysis of variance (ANOVA). Figure 2 shows the mean (*SE*) percentage of higher guesses per card.

This analysis resulted in a main effect of Card ($F(8, 592) = 1160.92$, $p < .001$, $\eta_p^2 = .940$), which shows that participants' guesses were influenced by the probabilities associated with the different cards. Post hoc analyses (Bonferroni-corrected; for all comparisons see Table S1 in the Supporting Information) revealed that the percentage of higher guesses was highest for cards 1–2 and slightly lower for cards 3–4, but guesses for these cards were still in the high range (above 90%). As expected, card 5 was associated with approximately 50% higher guesses, which was significantly less than for cards 1–4 and significantly higher than for cards 6–9. Finally, card 9 was associated with the lowest percentage of higher guesses, and although cards 6–8 were associated with slightly more higher guesses, percentages were in the low range (below 10%). Taken together, guesses followed the expected dichotomous pattern.

The ANOVA also revealed a main effect of Peer presence, $F(1, 74) = 4.55$, $p = .036$, $\eta_p^2 = .058$, qualified by a Card × Peer presence interaction, $F(8, 592) = 2.40$, $p = .015$, $\eta_p^2 = .031$, showing that the effect of the presence of an online peer varied as a function of card condition. Post hoc analyses (Bonferroni-corrected) revealed that for card 5 ($p = .044$) and card 8 ($p = .002$), participants guessed that the next card would be higher more often in the alone compared to the peer advice condition.

The interaction between gender and peer presence was not significant, indicating that the effect

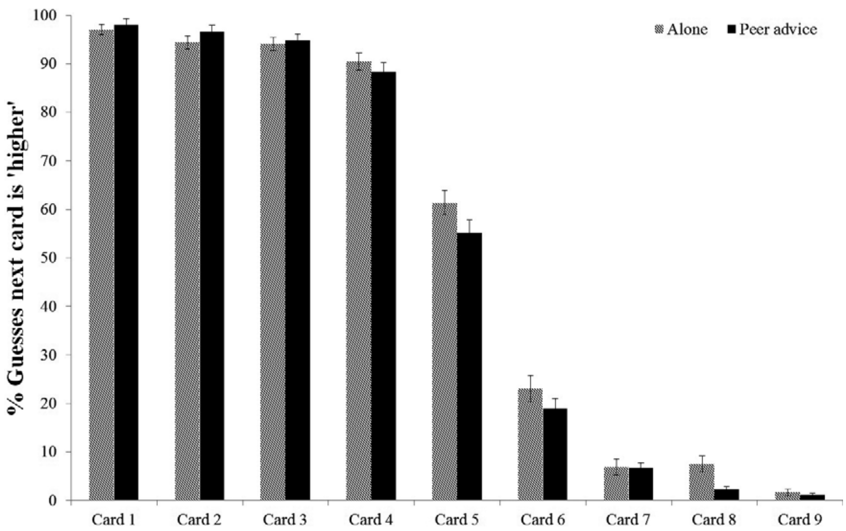

FIGURE 2 Means (*SE*) for the percentage of guesses that the next card drawn will be higher for each card condition and peer condition. Alone trials are displayed in patterned bars and peer advice trials are displayed in black bars.

of peers on guesses was similar for males and females. Lastly, there was an interaction between card and gender, $F(8,592) = 3.81$, $p < .001$, $\eta_p^2 = .049$. The differences between the genders were specific to card 2 (males > females, $p = .044$), card 6 (females > males, $p = .017$), and card 8 (females > males, $p = .043$). In these three conditions, males tended to follow the probabilities associated with the cards more than females, respectively, a higher % of higher guesses for card 2 and a lower % of higher guesses for cards 6 and 8.

Peer Advice and Gambling Behavior

Next, we tested whether the type of advice given by the online peer influenced the number of chips bet by participants. In these analyses, we included only *rational* trials (i.e., trials in which participants guessed higher for cards 1–4 and lower for cards 6–9) because this is a more conservative test that reduces noise in the data. This selection led to the removal of 4.42% of the data (see the Supporting Information for the results from analyses including all trials). Cards with equal probabilities were combined into five card conditions (card conditions 1&9, 2&8, 3&7, 4&6, and 5). For this analysis, card condition 1&9 was left out, because for those cards, the peer advice was always to bet 9 chips. Therefore, in the analyses presented below, we included four card conditions.

A repeated-measures ANOVA was performed with advice (4; alone, low, medium, high advice) and card condition (4; cards 2&8, 3&7, 4&6, and 5) as within-subject factors and gender (2; male, female) as between subjects factor. This analysis yielded two main effects for advice ($F(3, 222) = 45.76$, $p < .001$, $\eta_p^2 = .380$) and card condition ($F(3, 222) = 245.70$, $p < .001$, $\eta_p^2 = .769$). These effects were qualified by an Advice × Card condition interaction, $F(9, 666) = 2.32$, $p = .014$, $\eta_p^2 = .030$). Means *(SE)* for number of chips bet per card condition are displayed in Figure 3.

Post hoc analyses (Bonferroni-corrected) were performed to examine how advice influenced bets for card conditions (for all post hoc comparisons, see Table S2 in the Supporting Information). In card conditions 2&8 and 3&7, there were significant differences between playing alone and low advice ($p = .001$ and $p = .016$, respectively), such that participants placed higher bets for the low advice condition than for the alone condition. However, in conditions 4&6 and 5, there were no significant differences between alone and low advice (both p's > .05). Furthermore, participants bet more chips for card conditions 3&7 ($p = .001$), 4&6 ($p < .001$), and 5 ($p < .001$), but not for 2&8 ($p > .05$) when medium advice was given compared to low advice. The contrast of medium versus high advice revealed that only for card conditions 3&7 and 5, participants placed more chips following high advice compared to medium advice (p's = .002). In these categories, participants bet more chips when they received high advice from peers than when they received medium advice.

Taken together, in all card conditions, the number of chips bet increased when high advice was given compared to when low advice was given

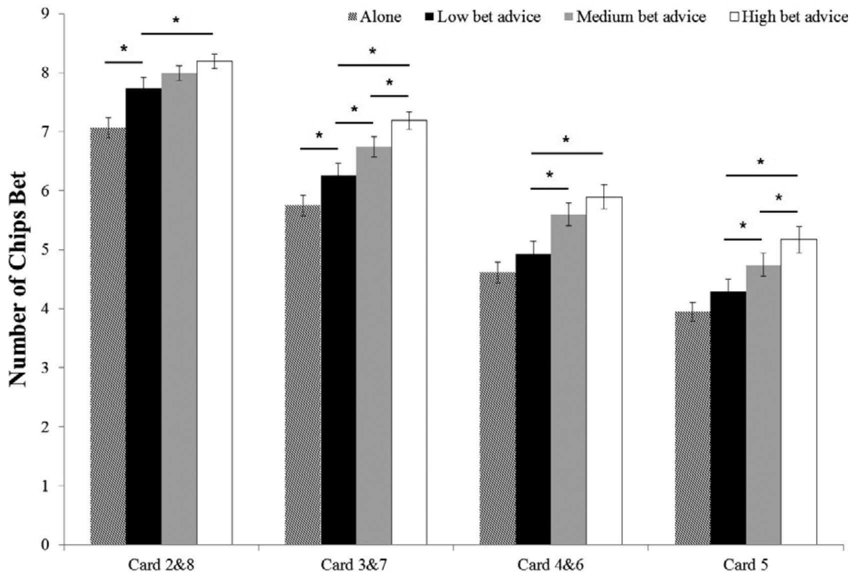

FIGURE 3 Mean number (*SE*) of chips bet for alone trials in patterned bar, low bet advice in black bar, medium bet advice in gray bar, and high bet advice in white bar for each card condition separately. *Indicates significant difference at $p < .05$ level (Bonferroni-corrected).

(card condition 2&8, $p = .038$; other ps < .001). This increase in bets was larger when higher uncertainty was associated with the outcome, from a 16% increase in the most certain 2&8 condition, to a 20% increase in card conditions 3&7 and 4&6, and a 30% increase in card 5. The difference in increase between card condition 5 and the other card conditions was significant (ps < .05), whereas the other comparisons between card conditions showed no significant differences (ps > .05).

Finally, there was an interaction effect of gender and card condition, $F(3, 222) = 2.89$, $p = .036$, $\eta_p^2 = .038$. Further analyses indicated that this effect was specific to card condition 2&8 ($p = .009$). Males bet more chips than females in this condition, M_{males} $(SE) = 8.09$ (.17), M_{females} $(SE) = 7.40$(.19). There were no gender differences in the other card conditions (all ps > .05). There was no Gender × Advice interaction ($p > .05$).

Reaction Times and Gambling Behavior

Lastly, we tested whether the type of advice given by the online peer influenced reaction times (RTs). We submitted average RTs to a repeated-measures ANOVA, with advice (4; alone, low, medium, high) and card condition (4; cards 2&8, 3&7, 4&6, and 5) as within-subject factors and gender (2; male, female) as between subjects factor. This analysis yielded main effects for advice ($F(3, 222) = 29.51$, $p < .001$, $\eta_p^2 = .285$) and card condition ($F(3, 222) = 11.27$, $p < .001$, $\eta_p^2 = .132$). These main effects were further qualified by an interaction effect of advice and card condition ($F(9, 666) = 9.20$ ($p < .001$), $\eta_p^2 = .111$). In addition, we found a main effect for gender ($F(1, 74) = 8.31$, $p = .005$, $\eta_p^2 = .101$). Overall, males ($M_{\text{males}}(SE) = 921.08$ ms (50.41)) responded faster than females (M_{females} $(SE) = 1144.98$ ms (59.11)). Mean RTs (*SE*) for each card condition separately are shown in Figure 4.

Post hoc analyses (Bonferroni-corrected) for the Advice × Card condition interaction showed that RTs did not differ for card conditions 2&8, 4&6, and 5 when playing alone compared to when low advice was given (all ps > .05). Only in card condition 3&7 was the RT for low advice shorter than for alone ($p = .024$). When we compared low advice versus medium advice, for card conditions 2&8, 3&7, and 4&6 RTs were shorter for low than for medium advice (ps < .001), but there was no difference in card condition 5 ($p > .05$). For card conditions 3&7 and 4&6, but not card conditions 2&8 and 5 (ps > .05), RTs during high advice were longer than for the medium advice (card condition 3&7, $p = .044$; card condition 4&6, $p = .002$). For all reaction time comparisons, see Table S2 in the Supporting Information.

DISCUSSION

The aim of the present study was to examine the effects of peer advice on risk-taking behavior from

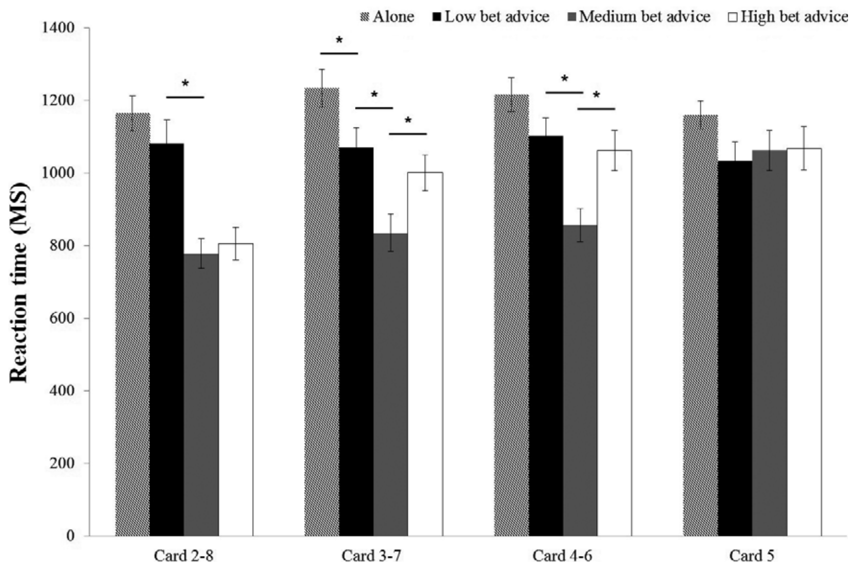

FIGURE 4 Average reaction times in MS (*SE*) for alone trials in patterned bar, low bet advice in black bar, medium bet advice in gray bar, and high bet advice in white bar for each card condition separately. *Indicates significant difference at $p < .05$ level (Bonferroni-corrected).

a social norms perspective. This was investigated with a card-guessing task, the Guess Gambling Game (GGG), in which participants received advice from online peers about their decisions. Before playing with peer advice, participants played some trials alone, without peer advice. The GGG included two types of decisions: a guess (is the next card higher or lower?) and a gamble (betting chips). Our key finding is that the effects of peer influence on gambling behavior were dependent on the uncertainty associated with the cards, as well as on the social norms conveyed by online peer advice.

The results of this study revealed that guesses showed a dichotomous pattern, which followed the outcome probabilities associated with the cards in both the alone and peer advice conditions. Consistent with prior studies, participants most often selected *higher* for cards 1 to 4 and *lower* for cards 6 to 9, while choices for card 5 showed a 50% probability (Critchley et al., 2001; Smith et al., 2014). The similarity between the guessing patterns when playing alone and with peer advice supports the notion that the presence of peers does not alter adolescents' ability to reason about card probabilities or expected value (Reyna & Farley, 2006; Van Duijvenvoorde & Crone, 2013; Van Leijenhorst et al., 2010).

As expected, gambling behavior was influenced by general peer presence. Participants placed higher bets when they played in the presence of online peers than when they played alone. These findings corroborate previous work showing effects of peer influence in information-limited contexts such as driving (Chein et al., 2011, age 13–16; Gardner & Steinberg, 2005, age 14–18; Munoz Centifanti et al., 2016, age 16–20) and information-rich contexts such as wheel of fortune tasks (Haddad et al., 2014, age 11–18; Smith et al., 2014, age 15–17). The current study extends this previous work, by showing that different types of advice yield a nuanced pattern of risk-taking behavior in interaction with varying uncertainty in 15- to 17-year-olds.

Peer Influence on Risk-Taking Behavior: Uncertainty and Social Norms

In the GGG, we used several card conditions, ranging from decisions with a highly uncertain outcome (card 5) to decisions with highly certain outcomes (e.g., card condition 2&8). In all card conditions, participants placed higher bets when they played with peer advice compared to when they played alone, and on average the number of chips bet decreased as uncertainty about the outcomes increased. Importantly, participants' decisions were influenced by the advice given by online peers. Participants placed higher bets when they were given high advice compared to low advice. Risk-taking with a high bet advice compared to a low bet advice increased with uncertainty of the gambles, from a small rise (16%) in the relatively certain condition to a substantial rise (30%) in the most uncertain condition. These findings suggest that for decisions with a relatively certain outcome, the presence of peers rather than the type of advice is the most important factor influencing decision making, whereas for decisions with a relatively uncertain outcome, the type of peer advice is the most important factor.

These findings are in agreement with social learning theory (Bandura, 1986). Similar to behavior in the domain of risky driving (Simons-Morton et al., 2011, 2014), gambling behavior varied according to different social norms. Moreover, in line with our hypothesis, peer norms were most influential in the highly uncertain situation (Cialdini & Trost, 1998; Smith et al., 2014). Learning from social norms in peer influence seems to play an important role in the variability seen in risk-taking behavior during adolescence. In general, adolescents tend to overestimate the degree to which their peers take risks and consequently adapt their behavior to that flawed perception (Prinstein & Wang, 2005). In the current study, however, social norms were made explicit by the advice of the online peers. Adolescents may have been inclined to conform to these norms because they wanted to be accepted by their peers.

Overall, analyses of the reaction times showed that peer presence did not simply facilitate the decision-making process. Under high uncertainty (card 5), participants made their decisions equally quickly when online peers provided them with advice and when they played alone. Interestingly, medium and high advice in card condition 2&8 facilitated the decision-making process (i.e., shorter reaction times), but low advice in the 2&8 condition resulted in longer reaction times, suggesting additional decision-making conflict. One alternative interpretation of these results may be that longer reaction times in these conditions are the result of confusion or disbelief in the task. However, we suggest that this seemingly contradictory effect of peer advice on reaction times is due to the nature of the advice. The advice to bet 1 or 2 chips is not rational in the relatively certain card condition, given that the probability of a favorable card is relatively high. We interpret this contradiction in reaction times as participants taking more time to think about their response upon encountering "irrational" advice.

Our results suggest that impulsivity alone cannot explain the effects of peer presence on reaction times (also see Krajbich, Bartling, Hare, & Fehr, 2015). Moreover, these findings are different from the findings from studies that focused on delay discounting (Gilman et al., 2014; O'Brien et al., 2011; Weigard et al., 2014) which did find an increase in impulsivity in the presence of peers; therefore, future studies should examine the role of impulsivity and the facilitating versus hindering effects of peers on reaction times in more detail (for a recent discussion on impulsivity, see Steinberg & Chein, 2015).

Gender Differences in Risk-Taking Behavior

A secondary goal of this study was to explore whether there were gender differences in susceptibility to peer influence on risk-taking behavior. Although subtle, the gender effect in guessing behavior seems to imply that males tended to guess more in line with expected value than females. In terms of gambling behavior, males showed more risk-taking behavior than females but only in relatively certain decisions. These risks in the relatively certain condition can be considered as an adaptive form of risk-taking behavior because the benefits (i.e., double chips) associated with this decision are far more likely to occur than the potential costs (Byrnes et al., 1999). These results fit with previous work on gender differences, showing that males are generally less risk-averse and more sensitive to peer influence than females (Byrnes et al., 1999; Steinberg & Monahan, 2007; Sumter et al., 2009). The "gender gap" in risk-taking behavior seems to vary with the type of risk-taking, age (i.e., decrease over development), and task context but is commonly found in gambling tasks (Byrnes et al., 1999).

Limitations

The age range of participants included in the present study was relatively narrow (15- to 17-year-olds). Although this sample is very comparable to the age range that was previously studied, is of specific interest in terms of brain development, and gave us the opportunity to explore individual differences in gender, it limits our ability to directly compare adolescents to children and/or adults. Given that the broader adolescent peer influence literature has included a larger age range (11- to 22-year-olds) and shows consistent effects of peer influence, we speculate that our findings may generalize to younger and older adolescent populations. Based on the literature, we expect that peer effects would be augmented in adolescents compared to adults (Gardner & Steinberg, 2005). Developmental comparisons would be a relevant extension of the present study and should be addressed in future research, such that we can test whether adolescents are more sensitive to social norms than children or adults.

Another possible limitation of this study is that the task order may have influenced the bets placed and reaction times between alone and peer advice trials, as all participants first played alone and then with peer advice. This order may have resulted in practice or learning effects, and therefore the results should be replicated with a counterbalanced design. Moreover, even though none of the participants reported disbelief in the online peer manipulation, this belief was not directly assessed.

Finally, the social situation provided in this experiment is less complex than social relationships in real life. A different anonymous online peer gave advice on every trial, such that there was no relationship involved between the participant and the peer, and each decision was equally important. We used anonymous peers in this task to control for possibly confounding assumptions about behaviors or beliefs of friends. However, to increase ecological validity, future research could address the effects of the opinions of real friends or include peer characteristics such as social status or likeability in a school environment (see e.g., Burnett Heyes et al., 2015; Welborn et al., 2016). Another interesting direction for future research would be to vary aspects of this task, for example, to investigate real-world situations with larger rewards or to examine social versus monetary reward.

CONCLUSIONS

This is the first experimental study that examined peer influence on risk-taking behavior from a social norms perspective. We showed that peers do not alter adolescents' ability to make a rational guess in line with probabilities. Rather, our findings implicate that peer effects on gambling behavior were more nuanced, depending on both social norms conveyed in peer advice and uncertainty associated with the outcome. Together, these results contribute to the understanding of the process underlying peer influence on risk-taking behavior. To gain a deeper understanding of this complex process, future studies should move beyond peer presence effects, to investigating what it is exactly about these peers that results in changes in behavior. In uncertain circumstances, it does seem to make a difference what crowd an adolescent hangs out with. This has important implications for interventions, for example, by informing the design of a peer intervention in which we can use peer advice to promote more cautious behavior that in turn may lead to reduced health-risk behaviors in adolescence.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article:

Table S1. Mean differences in % guesses that the second card will be *higher* for all card comparisons.
Table S2. Mean differences in chips bet and reaction times for all combinations of advice types.