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Inhibition as a factor underlying susceptibility to peer influence in adolescents with MBID

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Abstract

It is known that adolescents with mild to borderline intellectual disability (MBID) take more risks than typically developing adolescents. To gain more knowledge in which factors underlies this increased risk-taking, this study investigated whether inhibition capacity is a predicting factor of susceptibility to peer influence in adolescents with MBID. To investigate this, a group with adolescents with MBID was compared to a typically developing control group. The sample comprised of 27 completed questionnaires, the Balloon Analogue Risk Task (BART; in a peer or solo condition), assessing risk taking and a stop signal task (SST) assessing inhibition. Analyses indicated that (a) risk taking behavior increased when manipulated with peer influence; (b) peer effects were not different for adolescents with MBID than typically developing adolescents; (c) adolescents with MBID showed no lower inhibition response compared to adolescents without MBID and (c) inhibition was not a predictor for increased susceptibility to peer influence. Surprisingly, these findings were not consistent with our hypotheses. However, this is the first study investigating the underlying mechanisms for susceptibility to peer influence in adolescents with MBID. Results of this study may serve as key directions for future research.

Introduction

1.1 Adolescence, risk taking and peer influence

Adolescence is a developmental stage between childhood and adulthood which often includes physical and mental changes (Steinberg & Lerner, 2004). This stage of life is marked by identity development, exploration and independence from parents (Crone & Dahl, 2012). It is also often associated with negative health indicators and mortality due to increased risky behavior such as alcohol and substance abuse, unprotected sexual intercourse, violence and impulsive driving (Dahl, 2004; Steinberg, 2004). Compared to children, adolescents have an improved reasoning capacity in decision-making. Despite the improved cognitive functioning, they show more ‘’reckless’’ behavior (Steinberg, 2010). Understanding more about adolescent risk-taking contributes to the development of an effective intervention to address these problems.

Studies have shown that most of the adolescent risk-taking occurs when peers are present, in comparison to when they are alone or in the company of an adult. (Albert & Steinberg, 2011; Simons-Morton, Lerner & Singer, 2005). An experimental study of Gardner and Steinberg, (2005) on peer influence showed that being in the presence of peers when performing risk-taking tasks increased risk taking behavior by 50% among adolescents, compared to the adult group where no impact was found. Additionally, reward and social stimuli are activated in the same brain area during adolescence. For this reason, adolescent risk-taking should not be separated from susceptibility to peer influence (Steinberg, 2010).

One explanation for the increased peer influence during adolescence is the crucial role peer groups play on healthy or unhealthy development of adolescents.

During adolescence, the need to be accepted by peers and social evaluation becomes highly salient (Blakemore & Mills, 2014; Somerville, 2013). For the adolescent, peer groups serve as a model to form their own identity. In order to attain uniformity and solidarity, adolescents are often pressured to adopt certain values, interests and styles similar to the crowd they associate themselves with (Brown, 2004; Padilla-Walker & Bean, 2009). The desire to gain status or to be accepted by peers may increase risk taking behavior (Blakemore, 2018).

Another hypothesis in literature about the underlying process of high risk taking in adolescents is based on the ‘‘dual systems model’’ of Steinberg (2010). This model hypothesizes that increased risk-taking during adolescence can be explained by the interaction between two neurobiological systems: a ‘‘socioemotional’’ system and a ‘‘cognitive control’’ system, that encounter significant change during this age period. During puberty, there is a dramatic increase in dopamine activity within the socioemotional system which potentially causes higher reward sensitivity (Strang, Chein & Steinberg, 2013). In opposition to the increased reactivity of the socioemotional system, there is an immature behavioral control mechanism. An imbalance in the two systems potentially causes increased sensitivity to immediate rewards, which can be obtained by risky behavior. Researchers propose that peer presence further increases reward-seeking behavior, regardless of negative consequences (O’Brien et al., 2011).

Researchers have also found that being in company with peers, has a negative influence on adolescents’ cognitive control functions which results in higher impulsivity when making decisions (Weigard, Chein, Albert, Smith & Steinberg, 2014). A form of impulsivity that adolescents show, is their preference for immediate small rewards compared to larger but postponed rewards (Romer, 2010). Different

studies show that this preference is even greater in presence of peers (O'Brien et al., 2011; Weigard et al., 2014) and often leads to risky behavior (Chein et al., 2011; Gardner & Steinberg, 2005). Not only is risky behavior in adolescence associated with risk-seeking, but it is also related to impulsivity and low cognitive control (Bjork & Pardini, 2015). Moreover, the study of Meldrum, Miller and Flexon (2013) showed low self-control to be a predictor for susceptibility to peer influence in adolescents. This could mean that adolescents with cognitive control deficits would be more prone to peer influence.

1.2 Adolescents with MBID

A group that is known to be even more susceptible to peer influence than typically developing adolescents are adolescents with intellectual disabilities. Adolescents with mild to borderline intellectual disability (MBID) show increased risk taking behavior in daily life such as delinquent behavior (Segeren, Fassaert, Kea et al., 2018), substance abuse (see Chapman and Wu, 2012), and sexual risk taking (McGillivray, 1999; Ramrakha et al., 2007). This study will focus on risk taking under peer influence in adolescents with MBID. In the present study, MBID is defined as those having a mild intellectual disability (IQ between 70 and 85) or borderline intellectual functioning (IQ between 55 and 85) with accompanying problems in their adaptive functioning. (Dekker, Koot, Van der Ende, & Verhulst, 2002; Emerson, Einfeld, & Stancliffe, 2011). Adaptive functioning is characterized by conceptual (academic), social and practical domains (American Association on Intellectual and Developmental Disabilities, 2010). Deficits in these domains result in failure to adequately function in daily life. Recently, with the introduction of the fifth edition of the Diagnostic and Statically Manual of mental disorders (DSM-5; APA,

2013), the different levels of severity of the ID are not determined by IQ-scores but rather based on limitations in adaptive functioning. In the Netherlands, there are approximately 313.000 children and adolescents diagnosed with MBID (Stoll, Bruinsma & Konijn, 2004; Van Nieuwenhuijzen, 2000). This is about 1,9 % of the Dutch population. The Dutch educational system separates individuals based on their educational ability. Most adolescents with MBID are educated in schools for special vocational education, whereas adolescents without ID are educated in regular education schools (Jansen et al., (2013).

1.2.1 Increased peer influence in MBID

One of the first and few experimental studies that indicated susceptibility to peer influence in MBID is the study of Khemka and Hickson (2006). The study showed that adolescents had a hard time making safe decisions under negative peer-pressure. These findings however, must be taken with caution for this study did not have a control group. This means that results were not compared with those of typically developing adolescents. For this reason, no conclusion could be taken about increased susceptibility to peer-influence in adolescents with MBID compared to adolescents without MBID. Bexkens et al. (2018) found a correlation between MBID and higher risk taking, but only when peer-influence was included. In the study, three factors underlying the increased susceptibility to peer influence in decision making were discussed. The first hypothetical explanation given was that limited social cognition in individuals with intellectual disability may increase vulnerability to misuse by peers. The second potential explanation given in the study was that low feelings of self-efficacy may elicit the fear to be rejected by others and therefore increase susceptibility to peer influence. The last potential explanation was that

limitations in the cognitive control in individuals with MBID may lead to more risk taking behavior. Low capacity of suppressing distracting information when making decisions may increase more risk-taking in this group. The current study will focus on this last factor.

1.2.2 Inhibition and MBID

The focus of the present study is to investigate whether inhibition contributes to the heightened susceptibility to peer influence in adolescents with MBID. As stated above, there is small evidence that adolescents with MBID have deficiency in their inhibition response, which may lead to risk taking in peer presence (see Schuringa et al., 2017; Bexkens et al., 2014). Response inhibition is described as the ability to withhold predominant action (Schuiringa, van Nieuwenhuijzen, Orobio de Castro & Matthys, 2016). Deficits in inhibition may cause impulsive, inappropriate responses and result in lower resistance to peer influence (Dekkers et al. 2017). A meta-analysis showed that individuals with MBID had poorer performance on inhibition than typically developing controls. (Bexkens, Ruzzano, Collot d'Escury-Koenings, Van der Molen, & Huizinga, 2013). In contrary Danielsson et al. (2010) did not find these inhibition effect differences between adults with intellectual disabilities and participants in the control group with average intelligence. Contrasts in these findings could be explained by the difference between the still-developing cognitive functions of mid adolescents compared to adults (Huizinga, 2007).

To provide a more complete view of the concepts that were measured, we used a multi-method approach (i.e. experimental tasks and self-report) to measure peer influence and inhibition. Studies have shown that laboratory-based tasks (performance on experimental tasks) and self-report (rating scale of everyday

behavior), measuring the same concept (e.g. impulsive behavior), often have different outcomes (Ellingson, Potenza & Pearlson, 2018; Le Bas, Hughes, Stout, 2015).

Moreover, the use of only self-reports has several limitations. Individuals may provide inaccurate reports due to the perceived negative consequences of reporting risky behavior (Lejuez et al., 2002). It is also well known that people with intellectual deficits have difficulties administering self-reports due to problems of understanding and communication (Emerson, Felce & Stancliffe, 2013). Nevertheless, self-report should be included to have more insight into the emotional or behavioral states of adolescents. Also, laboratory-based measures may be an important complement to self-report measures because they elicit actual situation-based characteristics not accounted for by self-report measures. Because self-reports and laboratory-based measures reveal different attributes related to risk, their combination could provide a more comprehensive assessment of peer influence and inhibition (Pharo et al., 2011).

Inhibition was assessed using the Stop Signal Task (SST; Verbruggen & Logan, 2008). The SST measures the ability to withhold dominant behavioral responses to stimuli. The SST consists of a go-task in which participants have to try to react as quick and accurate as possible to a go stimulus. After the go signal, a stop signal follows (often an auditory stimulus, but in this study a visual stimulus was used), indicating that participant should inhibit their motor response (Verbruggen & Logan, 2008). An advantage of the SST is that the required time to suppress initiated responses ("inhibition reaction time"), which is normally not observable, but can be calculated empirically. The "inhibition reaction time" is known as the Stop Signal Response Time (SSRT; Eagle, Baunes, Hutcheson et al., 2007). The SSRT is often used as an index of inhibitory control in research on Attention Deficit Hyperactivity Disorder (ADHD). A lower SSRT indicates a better capacity for inhibition response.

Inhibition was additionally assessed with a self-report measurement. The clinical inhibition scale of the Behavior Rating Inventory of Executive Function-Self-Report (BRIEF-SR; Guy, Isquith & Gioia, 2004) was used to measure inhibition.

1.3 Risk taking with peer manipulation

There are various ways to examine risk-taking in the laboratory. Several studies unveiled a correlation between the Balloon Analogue Risk Task (BART) and different risk-taking behaviors in daily life such as gambling, unprotected sexual intercourse, unsafe driving aggressive behavior and delinquency (Hunt, Hopko, Bare, Lejuez & Robinson, 2005; Lejuez et al., 2007). More importantly, studies have shown that the BART is an effective task to measure risk taking behavior (Lejuez et al., 2002). During the task participants are instructed to virtually inflate an empty balloon for which they receive a small amount of money after each pump. Participants have the choice to stop pumping at any given time and save the accumulated money or to keep on pumping, risking the balloon to explode and losing the accumulated money. Each pump increases the risk for the balloon to explode, but also the amount of money gained (e.g. see *Figure 1*).

To assess peer influence effects on risk-taking behavior, we used the BART and adapted it to include a peer influence component. This condition of the BART, with peer manipulation, is based on prior studies where the effects of peer-influence on adolescent risky behavior was measured (Gardner, & Steinberg, 2005; Bexkens et al. 2018). The paradigm that will be used in the present study is very similar to the one used in the study of Bexkens et al. (2018). Similar to Bexkens et al. (2018) peer influence will be standardized by using unknown peers. This lowers the chances of variation in peer-relationship between adolescents. Secondly, mixed risk-encouraging

statements will be used to encourage risk-taking behavior and discourage safe decision. A difference in the model used in the current study compared to Bexkens et al. (2018) is that in the current study we used a ‘’within subjects’’ design, instead of a ‘’between subjects’’ design. Adolescents with MBID performed both the BART with peer manipulation and without peer manipulation. In the study of Bexkens et al. (2018) adolescents with MBID were assigned to either the peer condition or the solo condition. A problem with this design is that it can lead to biased results due to the heterogeneously of the MBID group, who often show comorbid with different mental health disorders (e.g. see Emerson et al., 2011). Using a between subjects design allowed us to compare different scores within the adolescent instead of comparing individual scores with each other, thus causing less biased results.

Secondly, to make peer presence more credible for the adolescents, adolescents interacted with peers through WhatsApp and were told that a peer was observing them through a camera whereas, in the study of Bexkens et al. (2018), pictures of virtual peers appeared on the screen combined with audio fragments. We expect stronger effects of susceptibility to peer influence with the combination of peer presence (Smith et al., 2014) and peer interaction (MacLean et al., 2014).

As for the self-report, the Resistance Peer Influence Scale (RPI; Steinberg & Monahan, 2007) will be used to measure adolescents’ ability to resist peer pressure.

1.4 Current Study and hypotheses

There has been evidence that adolescents take higher risks when peers are present. An explanation of this increased risk-taking behavior in adolescents with MBID might be a higher susceptibility to peer influence compared to adolescents without MBID (Bexkens et al., 2018). Previous studies have also shown that

adolescents with MBID have deficits in their cognitive control functioning (Bexkens et al. 2014; Schuiringa et al. 2017). Moreover, inhibition is known to be an essential factor of cognitive control (Ridderinkhof et al. 2004). Therefore, limitations in inhibition might play a role in the real-life risk-taking behavior of adolescents with MBID (Meldrum et al. 2013). This leads to the question of whether deficits in inhibition increase susceptibility to peer influence in adolescents with MBID. The current study aims to investigate whether lower inhibition capacity contributes to the underlying process of increased susceptibility to peer influence in adolescents with MBID using a multi-method approach. To measure this underlying factor, we divided the study sample into two groups: adolescents with MBID and a control group existing of adolescents without MBID. We predict the following three hypotheses:

Hypothesis (1) adolescents in both groups show higher risk taking behavior in the presence of a peer compared to when peers are not present. Risk taking in the BART peer condition is higher compared to risk taking in the BART solo condition. (2) Adolescents with MBID show higher susceptibility to peer influence compared to typically developing adolescents. The difference between risk taking behavior in the BART peer and BART solo is greater in the MBID group compared to the control group. Additionally, there will be a main effect of MBID on the RPI, but no main or interaction effect of the control group. (3) Compared to typically developing adolescents, adolescents with MBID show poorer inhibitory ability. We expect adolescents with MBID to show deficits in inhibitory control, in terms of worse inhibition performance (longer SSRTs) on the stop-signal task and a higher T score on the BRIEF-SR inhibition scale compared to the control group. (4) Lower inhibition capacity predicts higher susceptibility to peer influence when taking risks. We expect to find an effect of inhibition on susceptibility to peer influence, as both cognitive

control deficits and peer influence are related to increased risk taking behavior (Bexkens et al., 2014; Chein et al., 2011; Reynolds et al., 2014). We hypothesise that longer SSRTs predicts a higher difference in adjusted pumps between the BART peer and BART solo. Additionally, we expect a correlation between the inhibition measurements (SST and BRIEF-SR) and susceptibility to peer influence (the difference between BART peer and BART solo).

Method

2.1 Participants

In total 30 adolescents between the ages of 15 to 18 years (M = 16.16 years, SD = 1.03) were recruited in this study. The study sample consisted of two groups: adolescents with MBID and a control group with typically developing adolescents. 14 adolescents with MBID were recruited at special education schools and 16 controls at regular secondary schools. All were selected from schools in the Netherlands. Assignment to the MBID and control group was based on intelligence level (below or above 85) and on school type. Adolescents assigned to the MBID group attended schools for special vocational education (‘praktijkonderwijs’), which have the following admittance criteria in the Netherlands: (1) a below-average IQ between 55 and 85 tested no more than 2 years before admittance; and (2) learning delays of 50% or more in at least two of the following areas: mathematics, reading accuracy and fluency, reading comprehension, and spelling. One of the delays should be in reading comprehension or mathematics. In addition, we classified all participants with an IQ below 85 in the MBID group. Adolescents in the control group all had an IQ score of 85 or higher and attended regular education schools with different educational levels (i.e. lower and higher vocational education and pre-university education). To have a

wide range of adolescents with MBID, adolescents with ID of different aetiology were included in the study. Informed consent was obtained from parents and adolescents. To obtain consent from parents, teachers from the regular and special education schools sent out a letter with information about the study and a request for online consent. Parents also filled in the Dutch version of the Strengths and Difficulties Questionnaire (SDQ-Dut; Goodman, 1997) about their participating child. Along with a list of all the participating students, mentors received the SDQ for teachers online and requested to fill in the questionnaire for all students individually. Additional information was provided to parents and teachers when needed by the researchers. All questionnaires and consent were completed online. The study was approved by the ethical committee of the University of Amsterdam.

Adolescents with visual, auditory, or hand movement disabilities were excluded from the study, in order to make sure all participants were adequate to participate in this research. Further selection criteria for inclusion in this study was: fluency in Dutch for the adolescents.

2.2 Procedure

Immediately before testing, adolescents read an information letter about the study and were asked to sign for their online consent. They were given permission to withdraw from participating in the study at any given time. This study was part of broader research measuring three underlying factors (inhibition, theory of mind and interpretation bias) of susceptibility to peer influence and therefore not all measurements were included in this study.

All tests were measured in an empty classroom at the adolescents' school. Measuring time was divided into two sessions over two different days, where

different measurements were obtained (see *Table 1* for an overview of the two sessions). Session one consisted of five measurements. First, the vocabulary and matrix Reasoning subtests of the Weschler Intelligence Scale for Children – Fourth edition (WISC-IV) or the Weschler Adolescent Intelligence Scale – Fifth edition (WAIS-V), depending on the participant's age, was used to have an indication of the adolescent's intelligence. Based on the intelligence score, adolescents were included or excluded from this study. This lasted for approximately 30 minutes. Next, participants filled in the SDQ which endured about 15 minutes. A short break of 10 minutes was inserted after completing the questionnaire. Participants then performed the BART solo or the BART peer depending on the sequence they were assigned to. In order to control for order effects and sequence effects in the BART, the order of the BART solo and BART peer was counterbalanced. Thus, the participant sample was divided into two sequences in which participants practiced the BART peer and BART solo in different orders. All participants performed the BART peer and the BART solo task. On the BART solo condition, the Resistance Peer Influence Scale (RPI) was administered. On the BART peer condition, The Basic Empathy Scale (BES) was administered. Both the RPI and the BES lasted approximately 15 minutes. Lastly, the Recognition task was performed. Session one lasted about 85 minutes in total.

Session two, which took place on a different day, consisted of six measurements. Firstly, participants performed the Signal Stop Task which lasted 15 min. After this, the Social Anxiety Scale for Children-Revised (SASC-R) was administered. Then, a short break of 10 minutes was inserted. After the break, participants performed the BART solo or BART peer depending on the sample condition. Next, the BRIEF-SR which took about 10 minutes was administered. Lastly, the BES or RPI was administered. Session lasted 95 min in total. At the end of

session two, participants were rewarded with 8 euro including their earnings from one of the BART tasks they completed as compensation for participation.

Table 1. *Overview of the tasks from the two sessions*

Session 1	**Session 2**
WISC-V *OR* WAIS matrix	Stop signal task
SDQ-self	SASC-R
BART solo *OR* peer	Hinting task
RPI + BES *OR* BRIEF-SR	BART peer *OR* solo
Recognition task	BRIEF-SR *OR* RPI + BES
Total measurement time:	
75-85 min	**75 min**

NOTE. Table represents all the measurements used in this study. Depending on the counterbalance scheme, participants are randomly assigned in condition BART solo or condition BART peer as the first session. When performing the BART solo the RPI and BES follow. When performing the BART peer the BRIEF-SR is administered.

2.3 Measures

2.3.1 Cognitive functioning

The Vocabulary and Matrix Reasoning subtests from the Dutch version of the Weschler Intelligence Scale for Children – Fourth edition (WISC-IV) was used to have an estimation of the intelligence of participants up to 16 years old, in both the experimental and control group. With the subtest vocabulary, participants were presented pictures or words that were said aloud and asked to verbally describe the presented item. On the subtest matrix reasoning, participants were presented coloured matrices with one visual pattern missing (empty box). The participant was then asked to select the missing pattern from a range of options that fitted in the empty box.

To estimate the intelligence of 17 and 18 year olds, the Weschler Adolescent Intelligence Scale – Fifth edition (WAIS-V) was used. The Vocabulary and Matrix Reasoning subtests have been used in other research to estimate overall intelligence

(Silverstein, 1970). Also, they have been shown to strongly correlate with the complete WISC-III (r = .86). The WISC-IV subtests have also been successfully used in previous research to estimate the intelligence of children with MBID (e.g., Van Duijvenbode et al., 2018).

2.3.3 Risk-taking behavior

The Balloon Analogue Risk Task (BART; Lejuez et al., 2002) was used to measure risk-taking behavior. The BART is a computerized test that models real-life risk behavior through the concept of balancing the potential for rewards versus losses. Before starting with the task, the test leader read the instructions on the screen of a Dell Latitude E5540, 15.6 in. notebook to the participant. Throughout the task, participants were presented with 30 balloons (30 trials) which appeared one at a time on the screen (Figure 1. illustrates a trial of the BART). Participants were instructed to pump the balloon to earn money. The size and value of the balloon increased by pressing the space bar on the keyboard. For each pump, €0.01 was accumulated in the balloon. Participants could stop pumping the balloon at a desired time and press the shift-key on the keyboard to save the money in a temporary bank. However, balloons could be overinflated and explode when pumping too many times. It was only possible to collect the money earned for the trial before the balloon exploded. If the balloon exploded before saving the money, earnings for that trial were lost and the value of the balloon on the next trial reset to €0.00. Each pump had a greater risk of exploding the balloon, but a greater potential reward. On the bottom-right of the screen, participants were able to see the value earned with the previous balloon. The value shown in the bank after the last trial was the total amount the participant earned from the task. The adjusted pumps, also described as the average pumps on non-

explosion trials, will be used as dependent variable (Lejeuz, Aklin, Zvolensky, & Pedulla, 2003). The BART has a test-retest correlation of r = 0.77 (White, Lejuez & de Wit, 2008). The version of the BART used in the current study was also used successfully in adolescents with MBID in the study of Bexkens et al. (2018).

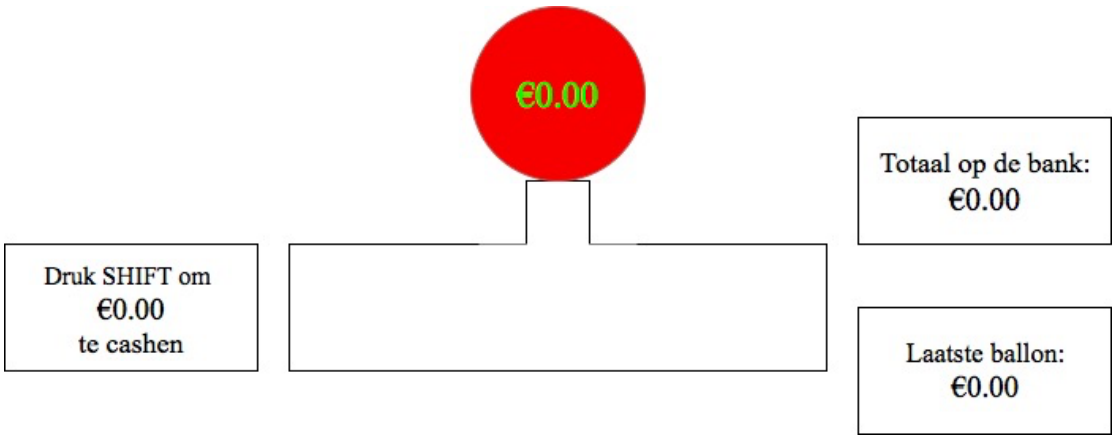

Figure 1. *Sample trial from the Balloon Analogue Risk Task (BART).*

2.3.3 Peer Influence

To measure peer influence, a modification of the BART, BART peer was used. All participants performed the BART peer as the BART solo. Differences in scores between the two BART conditions were used as an indicator for susceptibility to peer influence. The BART peer was identical to the BART solo except, a peer influence variable was added. Participants were made to believe that a peer, participating in different research at another secondary school, attempted to predict their performance on the BART by observing them through a camera lens. Participants were told that the goal of that research was to investigate whether an individual is able to predict someone's behavior with little information. Furthermore, they were told that the peer had already completed the task and had to make predictions about the participants' performances based on experience with the task, a

short conversation with the participant on *WhatsApp,* and observation of the participant through a camera. The camera that was used in the current study is a unit of the Luvion Easy Baby phone. The second unit is the monitor. The monitor was used by the second test leader to observe the participant and insert the *WhatsApp* messages at the right moments. The second test leader was located in another room and pretend to be the peer. The camera was placed behind the participant to allow the test leader to view the computer screen when the participant was performing the task. To communicate with the peer through *WhatsApp*, participants received a special research smartphone (Huawei). Once the first test leader finished explaining the participant about the peer and the camera, the test leader waved to the camera. This was a signal for the second test leader to start introducing the peer to the participant through *WhatsApp*. Participants were instructed to introduce themselves by only telling their name, age, class, school name and spare time activities. They were also instructed to send a picture of themselves (‘’*selfie’’*). To standardize the conversations, the test leader was only allowed to send scripted messages. Possible responses to messages from participants that were not scripted had to remain as neutral as possible (e.g. ‘’oke’’ to neutral commentaries and ‘’haha’’ to funny commentaries). *WhatsApp* messages were sent after the practice trials and during the break. The messages consisted of both statements that encourage risk taking behavior, thus more pumping such as: ‘’*I thought you would pump more, loser*’’ and discouragement of safe decisions such as ‘*’Only losers pump that little.’’* After finishing the task, participants received a last message from the peer to close off the conversation.

Self-Report

Susceptibility to peer influence was additionally measured with the Resistance Peer Influence Scale (RPI; Steinberg & Monahan, 2007). This test measures an individual's ability to resist peer pressure and behave according to one's own wishes. The scale contains a series of 10 pairs of statements. Each item consists of two opposing statements, and participants are instructed to appoint which statement most closely reflects their behavior (*Figure* 2 graphically illustrates an item from the RPI). After choosing the best descriptor, participants are then asked to score the descriptor as ''really true'' or ''sort of true''. Each item is scored on a 4-point likert-type scale from 1 = *really true* for the less peer-resistant statement to 4 = *really true* for the more peer-resistant statement. The maximum score is 40 and higher scores indicate greater resistance to peer influence and lower scores correspond with susceptibility to peer influence. The RPI likert-type scale has shown to be highly reliable ($\alpha > 0.70$) and valid (Steinberg and Monahan 2007).

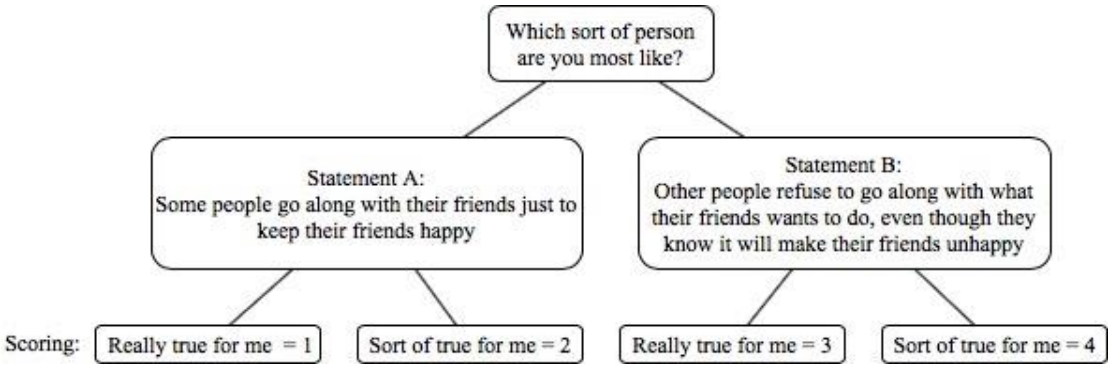

Figure 2. *Example of an item of the Resistance to Peer Influence Scale (RPI)*

2.3.4 Inhibition

Inhibition was assessed using the Stop signal task (SST; Logan, Cowan & Davis, 1984). The SST is a computerized task that measures inhibition response. The

SST was performed using the E-prime program. The SST consisted of 4 blocks of 52 trials each including a trial block of 52 trials. As a starting signal for each trial, a black cross against a white background was presented in the centre of the Dell Latitude E5540, 15.6 in. notebook screen (500 ms). The cross was then followed with a series of go stimuli, green coloured arrows that were randomly pointing left- and rightwards, to indicate the go signal (1000 ms). Participants were instructed to respond as quickly and accurately as possible to go signals, by pressing the left or right button on the response box with their thumb, depending on the direction of the arrow that was presented on the screen. In between each trial, there was an average interval of 1400 ms. On a subset of trials (25%), the stop signal; a red coloured arrow, was presented after the go stimulus appeared which lasted for 250 ms. Participants were instructed to withhold their response when the stop signal was presented. The interval between the go and the stop signal, the Stop Signal Delay (SSD), systematically varied depending on the participants' response to the stop signal. Successfully inhibited responses to stop the signal decreased the SSD by 50 and unsuccessfully inhibited responses to a stop signal (pressing a button when the stop signal is presented) increased the SSD by 50 ms. Decreasing the SSD increased difficulty to the next stop trial and increasing the SSD facilitated performance on the following stop trial. At the beginning of each block, the SSD was reset to 250 ms. This tracking system caused about 50% successful and unsuccessful inhibition responses. To encourage the participants to respond as quickly and accurately as possible, the results of their performance on the task appeared on the screen after every block. This consisted of the average reaction time on go signals, the SSD, percentage of missed go signals and percentage of accurate reactions on go and stop signals. Participants were given feedback on their performances after every block by

the test leader (i.e. ‘’everything looks fine, keep it up’’ when no specialties were seen or ‘’don’t forget to stop when the arrow is red’’ when accurate reactions on the stop signals were less than 30%). This encouraged participants to react quickly and it increased the chance of successful inhibition. As an outcome measure for the required time to suppress the response, the Stop Signal Response Time (SSRT) was calculated using the mean method (Verbruggen and Logan, 2009). This was calculated by subtracting the SSD from the go response time. Research shows that the mean method is a reliable and valid measuring instrument for the calculation of the SSRT (Verbruggen and Logan, 2009).

Self-Report

Inhibition was additionally assessed with the Behavior Rating Inventory of Executive Function-Self-Report (BRIEF-SR; Guy, Isquith & Gioia, 2004). The BRIEF-SR is invented to measure the executive functions of adolescents between the ages of 11 to 18 years old. It is intended to capture the older children’s and adolescents’ view on their self-regulation in their daily life and can serve as a screening tool for possible executive dysfunction. Primitively, the BRIEF-SR consists of 80-items and eight clinical scales: inhibition, shift, emotional control, monitor, working memory, plan/organize, organization of materials and task completion. In this study, however only the inhibit scale was used. This 9 item-scale measures the participants’ capacity to withhold behavior at the appropriate time. Example items include ‘’I act too wild or ‘out of control’’’ and ‘’I have trouble sitting still.’’ Participants were instructed to indicate on a three-point scale (1 = *never*, 2 = *sometimes* and 3 = *often*) to what extent each item applied to them in the past six months. To interpret the participant’s inhibition level, the T-score was used. This

score provided information about the participant's score compared to respondents in the standardization sample. T scores above 65 are considered clinically significant. Two validity scales: inconsistency and negativity were used to provide a general picture of the behavior of the participant. The negativity scale indicated the extent to which the participants answered the items in a negative manner and the inconsistency scale measured the extent to which the participant answered similar items in an inconsistent manner. In the current study, the Dutch version of the BRIEF-SR was used (Huizinga & Smidts, 2011) with demonstrated internal consistency of $r = 0.89$.

3. Data Analysis Plan

3.1 *Demographic variables*

All data analyses were conducted with Statical Package for Social Studies version 24.0 (SPSS). Descriptive statistics was used to observe the basic features of all participants, and level of significance was set at $p < .05$ (two-tailed). Before testing the hypotheses, standardization checks were performed. Depending on the distribution of the data, the mean and standard deviations, medians and interquartile ranges or frequencies and percentages were given for every variable. In order to include possible differences in the groups (MBID, control) as covariate in the study, the groups were compared on all variables. All variables of interval measurement level were tested using the independent samples t-test. Furthermore, the non-parametric test, Chi-Square test was used to compare variables of nominal (here: gender) or ordinal (here: socioeconomic status) measurement level in both groups. Shapiro-Wilk test was used to examine the normal distribution of the data. To measure homogeneity, Levene's test was used. An a priori power analysis was conducted with

Gpower and indicated that 136 participants or more were necessary to obtain a power of 0.8 and interactions with a medium size of ($f = 0.25$).

3.2 *risk taking under peer influence*

With regards to the first and second hypothesis, we conducted a repeated measures ANOVA (RMA) analysis with group as between-subject factor (MBID, control) and BART condition (BART peer, BART solo) as the within-subject factor. To answer the first question, if there is increased risk taking behavior when exposed to peer influence, we checked the tests of within-subjects effects of the RMA. We expected a significant main effect of BART condition with higher adjusted pumps on the peer condition compared to the solo condition. To answer the second question, if there is an effect of MBID on risk taking with peer manipulation, the pairwise comparisons table was examined. We expected an interaction effect between MBID and BART condition with higher difference in adjusted pumps between the BART peer and solo condition in the MBID group compared to the control group. Also, we expected the MBID group to have a higher number of adjusted pumps than the control group in all BART conditions.

To measure the main effect of MBID on the RPI, an independent t-test was used on means RPI scores and group as the independent variable.

3.3 *inhibition*

The difference between the MBID group and control group on inhibition was measured. First, the mean Go reaction time (RT), SSD and SSRT were measured for all participants in both groups. To assess the effect of MBID on inhibition, a one-way analyses of variance (ANOVAs) was performed with SSRT, as the dependent

variables and group (MBID, control) as between factors. We expected a main effect of MBID on inhibition with higher SSRTs on the MBID group compared to the control group.

Additionally, the mean T-scores on the BRIEF-SR indices inhibition were measured for both groups. In order to compare the difference between MBID and the control group on inhibition, a t-test for independent samples was conducted with mean T-scores as dependent variable.

3.4 *inhibition and susceptibility to peer influence*

Finally, to measure whether inhibition is a predictor of susceptibility to peer influence in the MBID group, a simple linear regression analysis was calculated. The difference between the adjusted pumps on the peer condition and the solo condition was computed as a new variable (BART difference) to indicate susceptibility to peer influence. The linear regression was conducted with the BART difference variable as the Y variable and SSRT (inhibition response) as the X variable. We expected a main effect of inhibition on peer influence susceptibility with higher SSRTs causing a higher number of adjusted pumps difference between BART peer and BART solo.

Pearson correlations between SST, BRIEF-SR and the BART were computed using successful inhibition (SSRTs), raw Total-T scores of the BRIEF-SR inhibition scale and the difference between the adjusted pumps on the BART peer and BART solo for the two study groups separately.

3.5 *Assumptions*

Before conducting the tests, all assumptions were checked. For the independent samples t-test, the scale of measurements applied that the data follows a continuous or ordinal scale. This assumption was met. Shapiro-Wilk test showed that the data was normally distributed. Furthermore, Levene's test showed homogeneity of variances between the groups.

For the assumptions of the repeated measures ANOVA, all dependent variables were measured on the continuous scale. This assumption was met for the adjusted pumps on both the BART peer as solo condition. The within-subject factor must be a categorical variable with at least two levels. This was also met, since group, being categorical is divided into two conditions; the MBID group and the control group. The dependent variables (BART Peer and BART solo) were normally distributed. This was measured through the use of normal Q-Q plots.

For the linear regression analysis, all variables were measured on a continuous scale. This assumption was met for SSRT, and BART difference. The Q-Q plot showed a normal distribution for all variables. Errors associated with one observation were not correlated with the errors of any other observation. And lastly, relationships among the variables were linear.

4. Results

4.1 *Sample characteristics*

A total of 30 individuals completed the tests. Data from three participants, who had a lower IQ-score than 85 in the control group, were excluded. The final sample therefore comprised of 27 individuals. No missing values were reported and no extreme values were found as outliers on both the SST task as the risk-taking task,

therefore all data was included in the analyses. A significance alpha level of 0.05 was employed for all analyses, and all tests were two-tailed.

To include possible differences as covariate in the study, an independent *t*-test was performed to check if the two groups did not differ on age or gender. Mean age, gender, IQ scores on measures of inhibition and risk taking, classified by group (control, MBID) are shown in *Table 2*. As can be seen, no significant differences were found between MBID and control group on age (p = .71). A difference was found on IQ between the MBID and control group. As predicted participants in the control group had a higher IQ-score compared to those in the MBID group (F (25) = 6.47, p < .001). Also, a significant difference was found on gender (p = .012). The data consisted of more boys (N = 20) than girls (N = 7). No variables were taken as covariate in this study.

Table 2. *Mean (SD) scores on key study variables by group.*

	MBID (*n* = 11)	**Control (*n* = 16)**	***t***	***p***
	M (*SD*/%)	**M (*SD*/%)**		
Age (years)	16.30 (.85)	16.16 (1.03)	-.37	0.71
Gender, Male/Woman	7/4 (63.6/36.3)	13/3 (81.3/18.8)	1.00	.012
IQ	77.23 (4.23)	101.09 (12.43)	6.11	0.00

Mean (M) and standard deviations (SD), number (n) and percentage (%) are reported, depending on the distribution of the data. MBID mild-to-borderline intellectual disability

All assumptions were checked before conducting tests on the data. A Shapiro-Wilk among with visual inspection of their histogram, showed that IQ-scores were not normally distributed for adolescents without MBID (df = 16, p = .03) and age was not normally distributed for adolescents with MBID (df = 11 p = .029). Levene's test showed homogeneity of variances between the two groups on all variables p > .05.

4.2 *Risk taking behavior under peer influence*

Hypotheses (1) and (2) were tested conducting a repeated measures ANOVA with group as between-subject factor (MBID, control) and BART condition (peer, solo) as within-subject. *Figure* 3. shows a visual outcome on adjusted pumps of both the MBID as control group. Sphericity test was not conducted because there were only 2 levels of repeated measures. Levene's test showed that the assumption of homogeneity of variances was met for both the BART peer condition (F (1,25) = .207, p = .653) and BART solo condition (F (1,25) = .376, p = .545). Multivariate results showed a significant effect Wilks' Lambda F (1,25) = 5.953, p = .022). This means that there was an overall significant difference between the BART peer and BART solo. RMA revealed a main effect of BART condition on adjusted pumps, indicating that BART risk taking was higher in the peer condition (50.13 ± 9.80 pumps, p = .022) compared to the solo condition (46.75 ± 10.72 pumps, p = .022; see *Table 3* for mean adjusted pumps in all conditions). With regards to the second hypothesis however, no significant difference was found on adjusted pumps between the MBID and control group (F (1,25) = .005, p = .943). This indicates no increased susceptibility to peer influence in the MBID group compared to the control group.

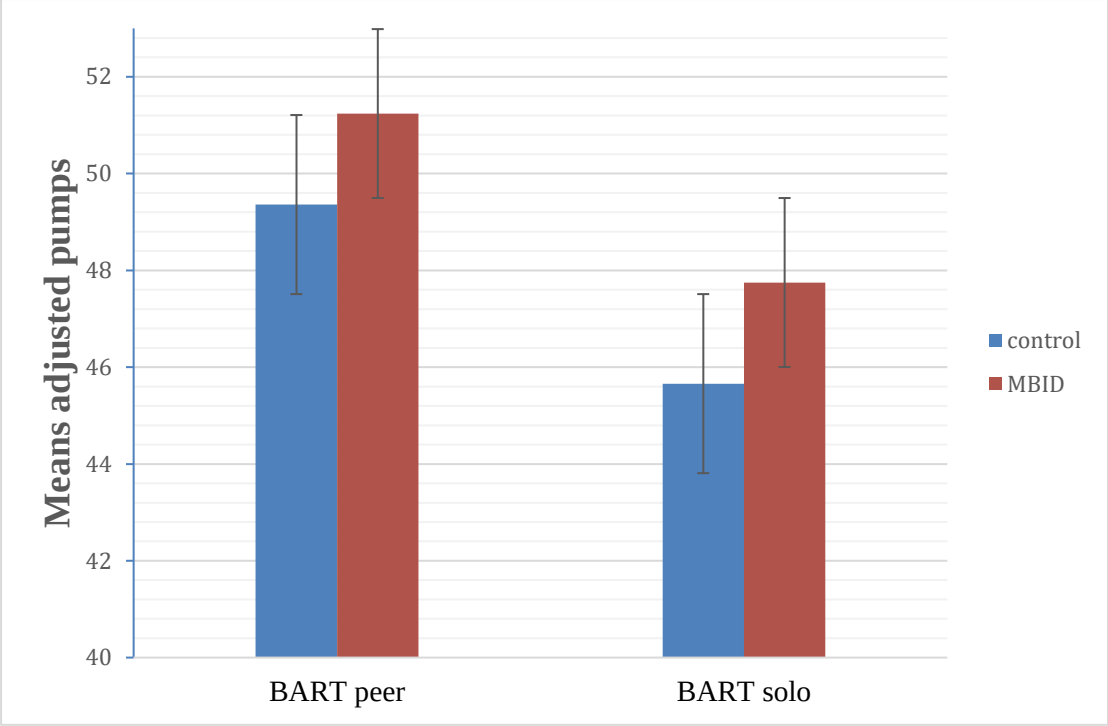

Figure 3. *Graph of comparison of the adjusted pumps on the BART conditions between the groups*

Table 3. *Table of means(M) and standard deviations (SD) of adjusted pumps on BART peer condition and BART solo condition*

	BART peer	BART solo
Control group (*M*/*SD*)	49.36/10.02	45.66/11.28
MBID (*M*/*SD*)	51.24/9.84	47.75/10.26
Total (*M*/*SD*)	50,13/9.80	46,51/10.72

Additionally, resistance to peer influence was tested with the RPI scale. An independent t-test was conducted to compare mean RPI scores between the two groups (MBID, control). RPI scores was used as dependent variable and group as independent variable. Levene's test for equality of variances indicated that the assumptions of homogeneity of variances was met (p = .768). Surprisingly, no main effect of MBID was found on the RPI scale, t (25) = -.640, p = .528, d = 12.7. In contrast to our expectation, adolescents with MBID did not significantly show less

resistance to peer influence (*M* = 30.45 ± *S*D = 5.57) compared to adolescents without MBID (*M* = 29.19 ± *SD* = 4.68). Therefore, no further tests were conducted.

4.3 *Inhibition*

Inhibitory ability was calculated using the SSRT (GoRT minus SSD) of each participant. The third hypothesis was tested using a one-way ANOVA with SSRT as dependent variable and group (MBID, control) as between factor, to compare the mean SSRT between the two groups. Levene's test showed that the assumption of homogeneity of variances was met (p = .167). Against our expectations, results showed no significant effect between the groups on inhibition response (F (1,25) = .494, p = .489). This indicated that Adolescents in the MBID group did not show significantly lower response inhibition (*M* = 212.67 ± *S*D = 36.18) compared to the control group (*M* = 202.44 ± *S*D = 37.88) therefore no further tests were conducted.

Additionally, inhibition is measured with the mean T-scores of the BRIEF-SR for all participants. An independent t-test was conducted to compare mean T-scores between groups (MBID, control). Levene's test showed that the assumption of homogeneity of variances was met (p = .842). Against our expectation, results showed no significant effect between the groups on inhibition response, t (25) = 1.58, p = .126. Adolescents with MBID did not show significantly lower response inhibition (*M* = 43.00 ± *SD* = 4.86) compared to adolescents without MBID (*M* = 46.06 ± *S*D = 4.99).

4.4 *Inhibition as a predictor for susceptibility to peer influence*

To investigate the hypothesis that lower inhibition capacity predicts increased susceptibility to peer influence in MBID, a linear regression analysis was used with

BART difference (susceptibility to peer influence) as the dependent variable and SSRT (inhibition response) as the predicting variable. Shapiro-Wilk test showed a normal distribution for both the SSRT (p = .178) and BART difference (p = .179) variable. As expected from previous analysis, results showed that inhibition response was not a significant predictor of susceptibility to peer influence, F (1,25) = 1.510, p = .231, with an overall model fit of R^2 = .057. Participants' predicted susceptibility to peer influence was equal to 13.494 + -.048 adjusted pumps when inhibition response is measured in seconds. Participants' score on inhibition response decreased .048 seconds for each adjusted pump indicating susceptibility to peer influence (β = -.048; t (25) = -1.229; p = .231). This indicated that adolescents with higher inhibition capacity were more susceptible to peer influence however, no significant results were found.

5. Discussion

The current study investigated whether higher susceptibility to peer influence in adolescents with Mild-to-Borderline Intellectual Disability (MBID) can be explained by individual differences in inhibition capacity, by comparing adolescents with MBID to typically developing controls. Other studies have shown that adolescents with MBID have an impaired inhibition capacity (Bexkens et al. 2014), which may contribute to this increased susceptibility to peer influence (Meldrum et al. 2013). With this knowledge, we expected a less developed inhibition capacity in adolescents with MBID, thus deteriorating their ability to resist peer influence. Against our expectations inhibition was not found to be a predictor of higher susceptibility to peer influence in adolescents with MBID. Four major results were found: (1); Adolescents showed more risk taking in presence of a peer (2);

adolescents with MBID did not show increased susceptibility to peer influence compared to typically developing adolescents (3); adolescents with MBID showed no lower inhibition response compared to adolescents without MBID (4) lower inhibition was not found to predict higher susceptibility to peer influence.

5.1 *Findings on risk taking behavior under peer influence*

As expected, we found that increased risk taking was correlated to peer influence. Both adolescents with and without MBID, showed higher risk taking behavior under peer influence. However, no significant differences were found between the groups. These results indicate that adolescents with MBID do not show higher risky behavior in the presence of peers compared to adolescents without MBID. This is not consistent with previous research where adolescents with MBID did show higher risk taking under peer influence on experimental risk-taking tasks (Steinberg and Monahan, 2007; Bexkens et al., 2018). A possible explanation for the absence of effects on MBID would be that we selected participants with MBID, without screening for adaptive functioning. This study only tested IQ and we did not test for other cognitive and/or social problems. However, all participants with MBID attended special vocational schools and had already a DSM-IV diagnosis. A related issue would be the inclusion of all participants who use medication for their disruptive behavior. Medication could possibly have decreased impulsive behavior and disturb effects of increased risk taking. Nonetheless, susceptibility to peer influence could not fully be affected in the peer condition. Future studies should take into consideration under which circumstances participants will be included to not influence a possible effect of risk taking.

Surprisingly, the same results were found on the self-reported questionnaire RPI. Results showed no effects of MBID on the RPI-scores. This suggests that the reported answers from adolescents with MBID did not indicate higher susceptibility to peer influence in this group. It is possible that adolescents with MBID do not completely report the correct risk taking behavior on self-reported questionnaires, which may have influenced the outcome on the RPI (Emerson et al. 2013). However, there is also evidence that children with intellectual disorder are able to administer self-reports (Douma et al., 2006). Future studies could include other informants such as parents and teachers to increase reliability.

5.2 *Findings on inhibition*

It was assumed that adolescents with MBID would have a lower inhibitory control compared to the control group. Analyses show that adolescents with MBID were slightly slower at withholding their automatic responses compared to adolescents without MBID, but this result showed not to be significant. This result was consistent with the results of the BRIEF-SR where the control group showed better inhibitory control compared to the MBID group. Nonetheless, these differences failed to reach significance. Our findings were inconsistent with the results of Bexkens et al. (2014) which indicated that individuals with MBID had poorer performance on inhibition than average intelligent controls. A potential reason for the unexpected result

5.3 *Findings on inhibition as a predictor of susceptibility to peer influence*

In the present study, we did not find that lower inhibition capacity leads to increased susceptibility to peer influence. These findings are in contrast with the

results of Meldrum et al. (2013). An explanation for this result might be the small sample size. Although no evidence was found on an association between inhibition and susceptibility of peer influence in adolescents with MBID, a special asset of the current study is that this study is the first study to investigate effects inhibitory control as a predictor for susceptibility to peer influence on MBID.

5.4 *Limitations and future directions*

A number of methodological limitations must be recognized. Firstly, there was a small sample size, with only 27 participants, while a-priori power analysis showed that a minimum of 136 participants were necessary for this study. It should be mentioned that this study is still ongoing which means that the number of participants will increase in time. To increase significant results and effect sizes, future studies should include a much larger sample size. Secondly, the current study assessed risk taking behavior using an experimental risk-taking task (Hunt et al. 2005; Lejuez et al. 2007), rather than a real-life risk-taking environment. The BART was a typical experimental task which fails to consider the emotional and social contexts of risk taking behavior (Steiberg, 2004; Steiberg & Cauffman, 2000). Compared to real-world risk-taking, decisions are made under conditions of emotional arousal. Future studies should include measures of real-life risk-taking (e.g. prevalence rates of reckless driving) so that experimental task results can be related to daily decision-making. Thirdly, peer influence was presented virtually (Bexkens et al., 2018) instead of physically. Adolescents did not physically see the peer, which could have led to lower peer influence effects and credibility of the adolescent. Fourthly, the sample of this study consisted of more boys (20) than girls (7). Other studies showed that boys show more delinquent behavior than girls (Rebellon et al., 2016). It is possible that

boys are less sensitive to peer influence compared to girls. Lastly, the overall test-battery contained 6 measures in total, which endured about 90 minutes in total. This could have influenced the concentration span of adolescents with MBID, since this group is known to have concentration deficits. This may have decreased the accuracy of their performances on the tasks and the questionnaires.

In conclusion, the current study did not find inhibition capacity to be a predictor for higher susceptibility to peer influence in adolescents with MBID. Also, we did not find differences in inhibition capacity between adolescents with or without adolescents. We did find that adolescents show higher risk taking behavior in the presence of a peer. However, the findings of this study must be interpreted carefully, because of low power. Despite the little evidence of this study, this is the first study to investigate inhibition capacity as a possible underlying mechanism to increased risk taking under peer influence. The current study may have practical implications and be a doorstep for future research on risk taking behavior in adolescents with MBID. A better understanding of the underlying mechanisms of risk taking in adolescents with MBID contributes to the development of effective interventions to reduce risky behavior in this group.

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