The effects of monetary and social rewards on task performance in children and adolescents: Liking is not enough

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Abstract

The current study compared the effects of reward anticipation on task performance in children and adolescents (8–16 years old) using monetary and various social rewards. Eighty-five typically developing children undertook the Monetary Incentive Delay (MID) task. Of these 44 also undertook the Social Incentive Delay (SID-basic) task where social reward was operationalized as a smiling face and spoken compliments. Forty-one children participated in the SID-plus where points were added to a pictogram with written compliments. In a preparatory validation study participants were asked how much they liked the SID-basic rewards. Results showed that there was an effect of reward size on accuracy and RT in both the MID task and SID-plus, but not SID-basic. Subjective value of the SID-basic rewards was rated higher with hypothesized increasing reward intensity. In conclusion, although the social rewards in SID-basic were liked by children and adolescents in the validation study, they had no effect on the behaviour. Only when points were added (SID-plus), anticipated social reward affected task performance. Thus our results highlight (i) the difference between likeability and reinforcing quality and (ii) the need for a quantifiable element to rewards for them to be reinforcing for children. Copyright © 2012 John Wiley & Sons, Ltd.

Introduction

Abnormalities in the processing of reward and reinforcement have been found in different psychiatric populations, such as attention deficit hyperactivity disorder (ADHD), autism spectrum disorders (ASD) and substance abuse (e.g. Geurts *et al.*, 2008; Goldstein *et al.*, 2008; Kohls *et al.*, 2009b). By definition a reinforcer is a stimulus event that, when presented contingently after a response, increases the probability of that response re-occurring in the future

(Skinner, 1979). A reward on the other hand is a positively valued stimulus event that, although often liked, may or may not be a reinforcer. We often assume that all rewards are reinforcers. But this may not be the case. Not all reinforcers are positively valued and not all rewards are reinforcers. Even money, a powerful reinforcer in many settings that is easy to quantify (Critchfield and Kollins, 2001), may actually not always act as a reinforcer. Tangible reinforcers, such as money, can decrease intrinsic motivation and consequently lead to reductions in contingency-driven responding

(Carton, 1996; Deci and Ryan, 1985). Nevertheless money is used as a reinforcer in many settings. Previous reward studies often focused on the effects of tangible rewards on task performance, with monetary gain most commonly used. However, the usefulness of these rewards in the context of education and parenting is limited for practical as well as ethical reasons. This means that parents and clinicians often rely on other more social rewards when working with children.

There is a history of research into the effects of tangible versus social rewards, mainly in adults (e.g. Deci, 1971; Sloane *et al.*, 1970), but some studies also focused on children. For instance, Unikel *et al.* (1969) found social rewards to be equally effective as tangible rewards in enhancing performance of lower socio-economic status children on a simple discrimination learning task. Despite the common use of social rewards with children (Vollmer and Hackenberg, 2001), systematic research investigating whether social rewards are actually reinforcing in relation to children's task performance is rather scarce. This issue has been investigated in recent studies (e.g. Demurie *et al.*, 2011; Geurts *et al.*, 2008; Kohls *et al.*, 2009a; Kohls *et al.*, 2009b). Geurts *et al.* (2008) tried to enhance social motivation by telling the participating children that they would compete with peers in a computer game. The responses of typically developing (TD) children in this study became faster, but not more accurate due to this manipulation. However, it is questionable if the paradigm really enhanced social motivation or rather primarily activated competitive instincts. Functional Magnetic Resonance Imaging (fMRI) studies show that cooperation and competition seem to result in the activation of a common frontoparietal network, but they are also associated with activations in different brain regions (Decety *et al.*, 2004). While cooperation is known to be a socially rewarding act that is associated with activation of frontal regions involved in reward processing, competition seems to be socially less rewarding than cooperation (Decety *et al.*, 2004). Kohls and his colleagues (Kohls *et al.*, 2009a; Kohls *et al.*, 2009b) used a fairly naturalistic social reward in the form of smiling faces and compared the effects of social and monetary rewards on cognitive control in children. Both social and monetary reward improved inhibitory performance, although monetary incentives had a substantially stronger effect than social incentives. One factor that was not taken into account in this study was variation in reward intensity. It is possible that the social reward used here was less intense than the monetary reinforcer.

Previous studies report a linear relation between the intensity of anticipated rewards on the one hand and reaction speed and intensity of the activation in reward-related brain regions (Knutson *et al.*, 2001; Spreckelmeyer *et al.*,

2009) on the other hand. Spreckelmeyer *et al.* (2009) and Rademacher *et al.* (2010) added the reward intensity aspect in their study on monetary and social reward anticipation in adults. Three types of smiling faces with increasing happiness intensity were used as social rewards. With increasing levels of reward intensity a proportional increase in brain activation intensity was observed, independent of incentive type. Reaction times (RTs) also decreased with increasing level of anticipated reward. Significantly faster RTs were found for all levels of anticipated reward compared with the "no outcome" trials (Spreckelmeyer *et al.*, 2009; Rademacher *et al.*, 2010) and for the highest reward trials compared with the lowest reward trials (Rademacher *et al.*, 2010).

In a previous study of our research group (Demurie *et al.*, 2011), social reward was operationalized as points, in combination with a pictogram of an interaction between two persons. One person in the pictogram approves the performance of the other person with thumbs up and a compliment in a text balloon. The compliments got stronger according to the points that could be won. We chose to add points to the compliments and pictogram because we wanted to have a quantifiable measure comparable to the monetary reward intensity. Similar to Rademacher *et al.* (2010) we found a linear effect of reward intensity on the performance of TD children, both for monetary and social rewards. However, one can argue that points cannot be considered to be ecologically valid social rewards. The use of points makes our social reward operationalization quantitatively and qualitatively different from the smiling faces in the social reward task of Spreckelmeyer *et al.* (2009). Moreover, the fact of having a cumulative measure motivated the children to obtain "as much as possible" money or points.

Thus, different forms of social rewards have been used in the studies described earlier, which can have a confounding effect on the effects of independent variables (Luman *et al.*, 2005), as not all forms of social reinforcement are necessarily equivalent (Vollmer and Hackenberg, 2001). Kohls *et al.* (2009b) suggested that it might be important to compare financial incentives with different kinds of social rewards, as it is possible that different sorts of social rewards (facial expressions, verbal praise, social movies, etc.) have a different reward value (Blatter and Schultz, 2006).

To address these issues in the current study and to clarify what makes social rewards reinforcing we compared the effects of the anticipation of different social rewards on task performance. First, is it the cumulative aspect of the points that motivates children to perform better, or can we find this performance improvement also in a social reward task with a higher level of ecological validity, based on the

task of Spreckelmeyer *et al.* (2009)? We expected that anticipation of both social rewards would cause an improvement in performance, with a more pronounced task improvement when points were added. Second, the effects of the social rewards were compared to those of monetary rewards (Kohls *et al.*, 2009b). Based on previous studies, a stronger performance improvement due to monetary reward anticipation was expected. Finally, to be able to distinguish between the effects of likeability and reinforcing quality, social rewards had been rated by participants in a validation study, who were asked how much they “liked” the rewards. We expected a linear relation between the rating of social rewards and their reinforcing effect on task performance.

Methods

Participants

A total of 85 TD children (8–11 years old) and adolescents (12–16 years old) participated in this two-phase study. In the first phase, 41 participants participated in the Monetary Incentive Delay (MID) task and the Social Incentive Delay task with points (SID-plus). In the second phase, we wanted to investigate the impact of the cumulative measure of the points in the SID task. Forty-four participants undertook the MID task and the SID task without points (SID-basic). All participants had an estimated full scale IQ (FSIQ) of 80 or more. Means and standard deviations for chronological age and estimated FSIQ are presented in Table 1. Groups were matched for chronological age ($p = 0.89$), estimated FSIQ ($p = 0.33$) and sex ratio ($p = 0.80$).

Participants were recruited through letters to local elementary and secondary schools and targeted advertisements in magazines. All children were nominated by their parents as not displaying behaviour problems. Parents and teachers were asked to complete questionnaires to obtain a view on possible psychological symptoms of the participating

children. Parents completed the Disruptive Behaviour Disorder (DBD) rating scale (Pelham *et al.*, 1992) to control for symptoms ADHD and other behavioural disorders and the Social Communication Questionnaire (SCQ; Rutter *et al.*, 2003) to control for autism. Teachers completed the DBD rating scale. Children who had (sub)clinical scores for parent or teacher ratings on these questionnaires were excluded from the sample. Intellectual functioning was assessed with the Wechsler Intelligence Scale for Children – third edition (WISC-III; Wechsler, 1991). Four subtests (similarities, vocabulary, block design and picture arrangement) were administered. The sum of these subtest scores gives a reliable estimate of the FSIQ (Grégoire, 2005). Children were excluded from the study if their estimated FSIQ was below 80. All participants and their parents gave written informed consent. The study was approved by the ethical committee of the Faculty of Psychology and Educational Sciences of Ghent University.

Validation of the stimuli for Social Incentive Delay basic task

In a first pre-study the subjective value of compliments was rated. Eighty-four typically developing children between 8 and 16 years old were asked to complete a questionnaire concerning the subjective value of the compliments, used in SID-plus. Participants were children who participated in the first phase of this study and an allied study in our research group. A seven-point Likert scale was applied, ranging from one (not valuable at all, no nice compliment), over four (neutral), to seven (very valuable, nice compliment). Based on this rating the best fitting neutral, medium and high rewarding compliment were selected. The neutral compliment was “OK” (mean subjective value = 4.44), the medium compliment “Good!” (mean subjective value = 5.32) and the high rewarding compliment “Wonderfully done!”

Table 1. Descriptive characteristics of the sample

	Group 1 <i>n</i> = 41			Group 2 <i>n</i> = 44			
	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	
Sex							
Male			29			30	$\chi^2(1) = 0.07, p = 0.80$
Female			12			14	
Age in years	12.21	2.41	41	12.16	2.36	44	$F(1,83) = 0.02, p = 0.89$
Children (<i>n</i> = 40)	10.04	1.20	19	10.14	1.22	21	$F(1,38) = 0.08, p = 0.78$
Adolescents (<i>n</i> = 45)	14.13	1.29	22	14.00	1.45	23	$F(1,43) = 0.09, p = 0.76$
Estimated FSIQ	108.29	9.65		110.59	11.95		$F(1,83) = 0.94, p = 0.33$

(mean subjective value = 6.50). These compliments were recorded by 16 adults (eight males, eight females). In a second pre-study the spoken compliments were combined with neutral, happy and very enthusiastic face stimuli. For the pool of face stimuli 48 photographs displaying three different facial expressions of 16 different persons (eight males, eight females) were taken from the NimStim face stimulus set, a database of facial expression stimuli (Tottenham *et al.*, 2009). The different combinations of faces and compliments were rated by 50 typically developing children between the age of 8 and 16 in an internet survey. Participants were children who participated in previous studies of the research group and children who were recruited through letters to local schools, youth movements and personal contacts. The children rated how nice it was to receive the compliment from that person, how nice what the person said was and how he or she looked. A seven-point Likert scale was applied, ranging from one (not nice at all), over four (neutral), to seven (very nice). The 10 best distinguishing picture-compliment combinations (five males, five females) were selected as rewards for SID-basic task (NimStim numbers 01, 02, 05, 07, 10, 22, 23, 28, 32, 34). There was an effect of intensity ($F(2,14) = 199.05$, $p < 0.001$). *Post hoc* analyses (Bonferroni) showed that subjective value (SV) of the face-compliment combinations was rated higher when the intensity of the faces' happiness and compliment value increased (SV "Ok" < SV "Good!" < SV "Wonderfully done!"; $p < 0.001$, $p < 0.001$ and $p < 0.01$, respectively).

Monetary and Social Incentive Delay Tasks

The tasks were based on the MID task of Knutson *et al.* (2001, 2003). Each task consisted of four blocks of 54 trials of six seconds, yielding a total of 216 trials. During each trial, participants saw one of three cue shapes (cue, 500 ms) signalling the potential reward intensity during that trial, followed by a black screen (pre-target delay with random variable duration, 2000–2500 ms) and then responded to the target stimulus (triangle or square) that appeared for 260 ms with a button press. Participants had to react within 500 ms for their response to be accurate and thus rewarded. After the post-target delay (1000–1500 ms, variable delay duration, dependent of pre-target delay duration), a feedback screen (1740 ms) notified participants of whether they had obtained money (MID), a smiling face (SID-basic) or points (SID-plus) during that trial and indicated their cumulative total at that point (only in MID and SID-plus). The order of the MID and SID tasks was counterbalanced among the participants.

We adapted the tasks in three ways compared to the original MID task. First of all, two target stimuli were used.

When participants saw a triangle, they had to press button one. When the target was a square, participants had to press button two. More cognitive effort is required in comparison with the original MID task, where subjects only reacted with a button press when they saw the target. Moreover, both accuracy and RT can be considered as measures of the performance of the participants. Second, in the original MID task difficulty was set such that participants would succeed on approximately 66% of all trials, based on RT during a practice session. In the current tasks performance level was not individually tailored and participants were only rewarded for a correct response quicker than a standard threshold. Thus, the amount of reward earned differed among participants. All participants correctly believed that they would receive the actual obtained amount of money at the end of testing. However, all participants received the same monetary reward (15 euro) at the end of the testing. Third, we used three versions of the task: a monetary reward task (MID task) and two social reward tasks (SID-basic and SID-plus). During the MID task, participants could win 0, 5 or 15 eurocents for a fast and correct reaction, depending on which cue was presented. All participants correctly believed that they would receive the obtained amount of money at the end of testing. In the MID task of the first sample the sound of a dropping coin was added to the visual feedback, as to make this MID task and SID-basic comparable with respect to auditory loads. During SID-basic, human faces with increasing intensity of happiness (neutral faces, happy face, exuberant face) were used, in combination with spoken compliments. As explained earlier, 30 photographs displaying three different facial expressions of 10 different persons (five males, five females) were taken from the NimStim face stimulus set (Tottenham *et al.*, 2009). A stimulus with the same shape, luminance and colour as the face stimuli, but without facial features was used as a no-outcome feedback. During SID-plus, reward was operationalized as 0, 5 or 15 points, in combination with a pictogram of an interaction between two persons (<http://www.sclera.be>). One person in the pictogram approved the performance of the other person with thumbs up and a compliment in a text balloon. The compliments got stronger according to the points that could be won and were different in each block, to avoid habituation. Examples are "OK" as a zero points compliment, "Well done" for five points and "You're a champion!" for 15 points. Figure 1 shows an example trial of each task.

Statistical analyses

Performance efficiency was expressed in terms of mean accuracy and mean RT of correct responses. 2 ("Condition":

Figure 1. A trial of the MID task, SID-plus and SID-basic.

SID-basic versus SID-plus) $\times$ 2 (“Age group”: child versus adolescent) $\times$ 3 (“Reward intensity”: neutral face/zero points versus happy face/five points versus enthusiastic face/15 points) and 2 (“Task”: MID versus SID) $\times$ 2 (“Age group”) $\times$ 3 (“Reward intensity”) designs were used in a series of repeated measures analyses, with Condition and Age group as between-subjects factors and Task and Reward intensity as within-subjects factors, with a 95% confidence level.

Responses faster than 150 ms were not taken into account for the analyses with RT. As 150 ms was the 0.5 percentile in the MID task in the SID-basic group, 0.1 percentile for all the RTs in the MID task in the SID-plus group, 0.5 percentile in SID-basic and 0.4 percentile in SID-plus, all responses slower than the 99.5, 99.9, 99.5 and 99.6 percentiles respectively were deleted also. By doing so, responses slower than 842 ms for the MID task in the SID-basic group, 1329 ms for the MID task in

the SID-plus group, 1017 ms for SID-basic and 961 ms for SID-plus were not taken into account for the analyses with RT.

Results

Comparison of different social rewards: SID-basic versus SID-plus

Effect on accuracy

A significant main effect of age group ($F(1,78) = 29.77$, $p < 0.001$) was found. Children [mean (M) = 0.59, standard deviation (SD) = 0.17] obtained lower accuracy scores than adolescents ($M = 0.78$, $SD = 0.12$). Furthermore there was a significant interaction between condition and reward intensity ($F(2,77) = 4.57$, $p < 0.05$; see Table 2 and Figure 2). For the participants of SID-basic, no effect of reward intensity was observed ($F(2,39) = 0.43$, $p = 0.65$).

Table 2. Mean accuracy and standard deviations for SID-basic, SID-plus and the MID tk

	SID-basic						SID-plus						MID					
	0			5			15			0			5			15		
	M	SD		M	SD		M	SD		M	SD		M	SD		M	SD	
<i>Accuracy</i>																		
Children	0.60	0.15		0.59	0.14	0.59	0.16	0.16		0.60	0.15	0.60	0.16	0.15		0.62	0.15	0.64
Adolescents	0.76	0.14		0.76	0.15	0.74	0.15	0.15		0.76	0.14	0.76	0.15	0.13		0.80	0.13	0.83
<i>RT correct responses</i>																		
Children	395.51	45.23		399.01	40.97	390.88	42.33	386.84	39.64	386.84	39.64	384.75	39.38	370.09	36.55	375.68	364.97	51.03
Adolescents	380.67	40.97		382.86	39.69	383.49	45.22	379.77	32.87	379.77	32.87	374.68	29.98	369.97	28.39	369.73	357.03	40.78

For the participants of SID-plus, a significant main effect of reward intensity was found ($F(2,37) = 5.05$, $p < 0.05$). *Post hoc* analyses (Bonferroni) showed that accuracy of these participants improved in the highest reward condition compared to the no reward condition ($\text{Acc } 0 < \text{Acc } 15$; $p < 0.01$).

Effect on RT of correct responses

A main effect of reward intensity was found ($F(2,75) = 5.92$, $p < 0.01$; $\text{RT } 0 = \text{RT } 5 > \text{RT } 15$), as well as a significant interaction between reward intensity and condition ($F(2,75) = 3.51$, $p < 0.05$). For the participants of SID-basic, again no effect of reward intensity was observed ($F(2,39) = 1.12$, $p = 0.34$), while for the participants of SID-plus, a significant main effect of reward intensity was found ($F(2,35) = 6.38$, $p < 0.01$) (see Table 2 and Figure 3). *Post hoc* analyses showed (Bonferroni) showed that RTs of these participants improved in the highest reward condition ($\text{RT } 0 = \text{RT } 5 > \text{RT } 15$; $p = 0.65$, $p < 0.01$ and $p < 0.01$ respectively). No main effect of age group was found ($F(1,76) = 1.22$, $p = 0.27$).

Monetary versus social rewards: SID versus MID tasks

SID-basic versus MID

Effect on accuracy. There were significant main effects for age group ($F(1,39) = 12.92$, $p < 0.01$) and task ($F(1,39) = 9.38$, $p < 0.01$; $\text{Acc MID} > \text{Acc SID-basic}$). Children ($M = 0.60$, $SD = 0.15$) obtained lower accuracy scores than adolescents ($M = 0.77$, $SD = 0.12$). Furthermore a significant interaction between task and reward intensity ($F(2,38) = 3.55$, $p < 0.05$) was found (see Table 2 and Figure 2). There was a main effect of reward intensity on the MID task ($F(2,40) = 3.26$, $p < 0.05$). *Post hoc* analyses (Bonferroni) showed that accuracy improved in the highest reward condition compared to the no reward condition ($\text{Acc } 0 < \text{Acc } 15$; $p < 0.05$). For the SID-basic task, no main effect for reward intensity was found ($F(2,39) = 0.4$, $p = 0.65$).

Effect on RT of correct responses. There were significant main effects for task ($F(1,39) = 18.89$, $p < 0.001$; $\text{RT MID} < \text{RT SID-basic}$) and reward intensity ($F(2,38) = 6.07$, $p < 0.01$; $\text{RT } 0 = \text{RT } 5 > \text{RT } 15$). A significant interaction between task and reward intensity ($F(2,38) = 9.65$, $p < 0.001$) was also found (see Table 2 and Figure 3). In the MID task there was a significant intensity effect ($F(2,40) = 10.59$, $p < 0.001$). *Post hoc* analyses (Bonferroni) showed that RTs of the participants decreased in the highest reward condition ($\text{RT } 0 = \text{RT } 5 > \text{RT } 15$; $p = 0.35$, $p < 0.001$ and

Figure 2. Effect of social and monetary rewards on accuracy (data for the entire group of participants).

Figure 3. Effect of social and monetary rewards on RT of correct responses (data for the entire group of participants).

$p < 0.001$, respectively). In the SID-basic task, no effect of reward intensity was observed ($F(2,39) = 1.12$, $p = 0.34$). No main effect of age group was found ($F(1,39) < 1$).

SID-plus versus MID

Effect on accuracy. There were main effects of age group ($F(1,38) = 22.45$, $p < 0.001$) and reward intensity ($F(2,37) = 8.52$, $p < 0.01$; see Table 2 and Figure 2). Children ($M = 0.61$, $SD = 0.16$) obtained lower accuracy scores than adolescents ($M = 0.81$, $SD = 0.10$). Furthermore, *post hoc* analyses (Bonferroni) showed that accuracy of all participants improved in the reward conditions ($\text{Acc } 0 < \text{Acc } 5 = \text{Acc } 15$; $p < 0.02$ for all contrasts). No main or interaction effects of task were found.

Effect on RT of correct responses. Only a main effect of reward intensity ($F(2,35) = 12.77$, $p < 0.001$) was found (see Table 2 and Figure 3). *Post hoc* analyses (Bonferroni) showed that RTs of all participants became faster with increasing reward intensity ($\text{RT } 0 > \text{RT } 5 > \text{RT } 15$; $p < 0.05$, $p < 0.001$ and $p < 0.01$, respectively). No main effects of age group ($F(1,36) < 1$) or task ($F(1,36) < 1$) were found.

Discussion

In the present study we compared the effects of anticipation of monetary and different kinds of social rewards on task performance of children and adolescents. If we compared all tasks, we only found a main effect of reward intensity on accuracy and RT of correct responses in the MID and

SID-plus tasks, but not in SID-basic. In SID-plus, points and written compliments in a pictogram were used as social rewards, while SID-basic used smiling faces in combination with spoken compliments. These results are not completely in line with our hypotheses. First, we expected that anticipation of both social rewards would cause an improvement in performance, with a more pronounced task improvement when points were added. However, we found no effect at all of anticipated smiling faces in SID-basic. In contrast to these results a main effect of reward intensity was found in two other studies comparing an MID task and an SID task with smiling faces (Rademacher *et al.*, 2010; Spreckelmeyer *et al.*, 2009). Rademacher *et al.* (2010) found a decrease in RT in the reward trials compared to the no reward trials and in the highest reward trials compared to the lowest reward trials, independent of reward type. Spreckelmeyer *et al.* (2009) also found a decrease in RT in the reward trials compared to the no reward trials. Second, a stronger performance improvement due to monetary reward anticipation was expected. However, no difference was found between task performance and the effects of anticipated reward in MID and SID-plus. Finally, the subjective value of the social reward stimuli in SID-basic was rated by 50 children and adolescents. Results clearly showed an effect of intensity: subjective value of the face-compliment combinations increased with increasing intensity of the faces' happiness and increasing compliment value. However, this intensity effect was not reflected in the behavioural data in the current study, as reward anticipation had no effect on the performance in this social reward task. Although individuals can differ in the importance which they assign to social rewards (Fershtman and Weiss, 1998), our results can probably be explained by the difference between the extent to which a stimulus is liked and observed as rewarding on the one hand and its reinforcing power on the other hand. Dai *et al.* (2010) found that the incentive or motivational value ("wanting") of a reward could be distinguished from its likeability or emotional value, which can be measured by for example an attractiveness rating. Berridge *et al.* (2009) reviewed affective neuroscience studies and concluded that these psychological processes map onto distinct brain reward systems to a marked degree. Furthermore, Liem and Zandstra (2009) found that children's wanting of snack foods decreased more than their liking after repeated daily consumption during three weeks. It is possible that the incentive value of the repeatedly offered compliments and smiling faces in our study reduced while these reward stimuli were still liked. Compliments in SID-plus were different in each block of trials to avoid habituation, while this was not the case in SID-basic. As positively valued stimuli can lose their reinforcing power after a time,

satiation of the compliments can have lowered the incentive value of the social rewards in SID basic.

Although the lack of reward intensity effect in SID-basic might be due to a low incentive value of repeatedly offered smiling faces and compliments, this probably does not account fully for the difference between the results in SID-plus and SID-basic. Why does anticipated reward in both the SID-plus and MID task lead to a decrease in RT and an increase in accuracy, while it does not in SID-basic? The pictogram and compliments in SID-plus are also offered repeatedly, yet in combination with points. This cumulative measure in SID-plus might possibly explain the different reward intensity effect in SID-plus and SID-basic. Both social reward in SID-plus and monetary reward in the MID task had a collectable and immediate aspect (Estle *et al.*, 2007). The fact of having a cumulative measure motivated the participants to obtain "as much as possible" money or points. Many participants set goals with regard to the amount of money and/or points they wanted to obtain during the tasks. Therefore, the fact that we did not find evidence for an effect of the social reward anticipation in SID-basic might possibly be explained by this aspect of the task. As Kohls *et al.* (2009a) suggested the amount and type of applied incentive, especially for social rewards, play an essential role in enhancing task performance. The effect of the cumulative aspect in our social reward operationalization has implications for daily practice of education and parenting. Our results support the use of behaviour report cards, where a child has to obtain several positive social evaluations of his behaviour and thus needs to score on a cumulative measure. Token economy systems, as an important and effective technique in behaviour modification, are also based on the accumulation of secondary reinforcers, that can be exchanged for other reinforcers (Matson and Boisjoli, 2009).

The current study suffers from some limitations. First, just as in the study of Kohls *et al.* (2009a, 2009b), it is possible that our social rewards were less intense than the monetary reinforcer. In the SID-plus, points were added to the compliments and pictogram because we wanted to have a quantifiable measure comparable to the monetary reward intensity. However, it is difficult to compare these two quantifiable rewards, since we do not know to how much money one point equals. It is even possible that the performance effect of the MID and the SID-plus was perhaps caused by the quantifiable rewards only and that the social reward had no additional effect, although this is not in line with previous research (Rademacher *et al.*, 2010; Spreckelmeyer *et al.*, 2009). In a validation study points and money can be compared regarding their rewarding effects. Second, although they

could not be exchanged for a material reward, points cannot be considered to be real social rewards and are qualitatively different from smiling faces. As mentioned, we chose to add points on top of the compliments and pictogram because we wanted to have a quantifiable measure comparable to the monetary reward intensity. Unfortunately, it is an intrinsic characteristic of social reward that it is hard to standardize and quantify this kind of reinforcement. While tangible reinforcers are quite easy to quantify, they can be standardized and delivered in a quite uniform way, social reinforcers are more influenced by different features (Vollmer and Hackenberg, 2001). It remains a challenge for future research to overcome this limitation and increase the ecological validity of social incentives in experimental research. It would be interesting to compare different operationalizations of social rewards (e.g. smiling faces, movies of familiar persons giving a compliment, etc.). As Piazza *et al.* (1999) suggested, not all forms of social reinforcement are equivalent (Vollmer and Hackenberg, 2001). The processing of different intensities of smiling faces is more demanding and less unambiguous than the simple notification of winning points. Given the existence of face processing difficulties in children with ASD or ADHD (Dawson *et al.*, 2002; Uekermann *et al.*, 2010), this factor should be taken into account when the current tasks are used with these clinical groups. Vollmer and Hackenberg (2001) see a major challenge in identifying the features that contribute to the effectiveness of social consequences. A direct within-subject comparison of different kinds of social rewards can shed new light on this issue. It might be interesting to use neuro-imaging techniques in these future studies. While previously studies of social reward have focused on the effects on behaviour and performance, fMRI and other imaging studies open up the opportunity to explore the effects of (social) rewards at a neuro-biological level. Finally, in our adapted

MID task performance levels were not individually tailored. This makes it possible that children with worse performance were more frustrated by the task and their performance. However, mean accuracy and RTs were not different in the two samples, suggesting that mean frustration levels might be considered comparable.

Conclusion

In conclusion, the results of the current study show that there is a difference between likeability and reinforcing quality of social rewards in children and adolescents. Furthermore, as can be seen with both monetary and social rewards, there seems to be a need for a quantifiable element in rewards to be reinforcing for these children and adolescents. Since reward tasks have been used in different psychiatric populations, the results of the current study may have implications for research in these clinical groups.

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Declaration of interest statement

The authors have no competing interests.

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