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A social network-based intervention stimulating peer influence on children's self-reported water consumption: A randomized control trial

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ABSTRACT

The current pilot study examined the effectiveness of a social network-based intervention using peer influence on self-reported water consumption. A total of 210 children (52% girls; *M* age = 10.75 ± *SD* = 0.80) were randomly assigned to either the intervention (n = 106; 52% girls) or control condition (n = 104; 52% girls). In the intervention condition, the most influential children in each classroom were trained to promote water consumption among their peers for eight weeks. The schools in the control condition did not receive any intervention. Water consumption, sugar-sweetened beverage (SSB) consumption, and intentions to drink more water in the near future were assessed by self-report measures before and immediately after the intervention. A repeated measure MANCOVA showed a significant multivariate interaction effect between condition and time (V = 0.07, $F(3, 204)$ = 5.18, p = 0.002, $p\eta^2$ = 0.07) on the dependent variables. Further examination revealed significant univariate interaction effects between condition and time on water (p = 0.021) and SSB consumption (p = 0.015) as well as water drinking intentions (p = 0.049). Posthoc analyses showed that children in the intervention condition reported a significant increase in their water consumption (p = 0.018) and a decrease in their SSB consumption ($p < 0.001$) over time, compared to the control condition (p-values > 0.05). The children who were exposed to the intervention did not report a change in their water drinking intentions over time (p = 0.576) whereas the nonexposed children decreased their intentions (p = 0.026). These findings show promise for a social network-based intervention using peer influence to positively alter consumption behaviors.

Trial registration: This RCT was registered in the Australian New Zealand Clinical Trials Registry (ACTRN12614001179628). Study procedures were approved by the Ethics Committee of the Faculty of Social Sciences at Radboud University (ECSW2014-1003-203).

Childhood obesity is among the most serious public health problems in the 21st century (WHO, 2015). At present, 11% of European (CBS, 2012) and 17% of American children (Ogden, Carroll, Kit, & Flegal, 2012) are estimated to be overweight or obese. Beyond the increased risk of becoming obese as an adult, overweight children have a higher risk of developing physical problems such as diabetes and cardiovascular diseases (WHO, 2015). The consumption of sugar-sweetened beverages (SSBs) has been identified as a major contributor to the obesity epidemic (Hu, 2013). Approximately 66% of children consume at least one SSB per day (Han & Powell, 2013), which can lead to an additional weight gain of 6.75 kg in one year (Apovian, 2004).

Research suggested that reducing SSB consumption may be an effective way to prevent children from becoming overweight or obese (Hu, 2013). Specifically, targeting SSB consumption by means of promoting water consumption – which has zero calories and can reduce cravings for SSBs – seems to be a promising approach (Hu, 2013). Unfortunately, several interventions that tried to stimulate water consumption have shown limited effects on changing children's behavior (e.g., Loughridge & Barratt, 2005; Muckelbauer et al., 2009; Visscher et al., 2010). A possible explanation is that most health interventions focused on prevention strategies on an

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individual level (Sharma, 2006), even though the social environment has been found to have a strong influence on people's eating and drinking behavior (Cruwys, Bevelander, & Hermans, 2015; Emmons, Barbeau, Gutheil, Stryker, & Stoddard, 2007; Salvy, de la Haye, Bowker, & Hermans, 2012). Especially among adolescents, social influence is an important factor in the initiation and maintenance of consumption behaviors (Patrick & Nicklas, 2005). Ample empirical studies have shown that children and adolescents adjust their intake to that of their table companions (Cruwys et al., 2015; Herman, Roth, & Polivy, 2003; Higgs, 2015). In children, social modeling studies have shown that peers can set a guideline or social norm in food choice and intake which is followed by others (see for review, Cruwys et al., 2015). Most of the social modeling studies have suggested implementing this knowledge into community or social network intervention approaches (Cruwys et al., 2015). In addition, there is a need for intervention research taking into account the social status of the peers, given that the modeling effect may be stronger for role models who have a specific status in class (Teunissen et al., 2012). Therefore, the present study aims to promote water drinking by incorporating the social modeling mechanism in conjunction with peer status among children.

A theory that integrates both social influence and social network status is Roger's diffusion of innovation theory. It explains how members of a social network model the behavior and idea's of others (Rogers, 1962, 2003). High status peers or 'influence agents' are individuals who have the most influence during the diffusion process due to their unique position in their social network, such as having a higher social status and more influence as a change agent (Rogers, 2003). Moreover, the ones who serve as role models in their social network are often most popular, well-liked, and trusted by others (Kelly, 2004; Valente & Pumpuang, 2007). The use of influence agents has already been applied successfully in the field of public health aimed at preventing HIV (Kelly et al., 1991) and decreasing tobacco use (Campbell et al., 2008; Valente, Hoffman, Ritt-Olson, Lichtman, & Johnson, 2003). In these interventions, the most influential peers were identified and trained to spread and sustain new norms of behavior within their social networks.

In the current pilot study, we also followed this social network approach and trained the influential peers to promote water consumption within their social networks. Children do not drink enough water and apparently this beverage is considered unpopular among this age group (Drewnowski, Rehm, & Constant, 2013). Therefore, the training of the influence agents itself was developed based on insights from two important social influence theories: self-determination theory (Deci & Ryan, 1985) and self-persuasion theory (Aronson, 1999). According to the self-determination theory, supporting individuals' need for autonomy, relatedness, and competence (e.g., by providing choices) leads to autonomous internalization of behaviors that were initially of extrinsic origin (Deci & Ryan, 1985; Soenens & Vansteenkiste, 2010). Based on this, the training was designed to support the autonomy of the influence agents in order to optimally motivate them to promote water consumption within their social networks. In the training, the influence agents were asked whether they actually would like to take on this role and, if so, providing them with the opportunity to determine for themselves how they would encourage their peers to drink more water. Research has shown that an autonomy-supportive smoking cessation intervention focusing on choice increased adolescents' autonomous motivation to not smoke (Williams, Cox, Kouides, & Deci, 1999). Similarly, self-persuasion is an effective manner to sustain behavior change because it increases people's intrinsic motivation to change (Mussweiler & Neumann, 2000) by placing them in situations where they are motivated to persuade themselves in order to change their own attitudes or behavior (Aronson, 1999). In line with this, the training persuades the influence agents to consume more water themselves when asking them to argue in favor of water ("Write down arguments about how you could consume more water yourself"; Miller & Wozniak, 2001).

The present pilot study was the first to test a social network-based intervention using peer influence on children's self-reported water drinking behaviors. The aim of this study was to examine whether the "Share H_2O" intervention could effectively promote water drinking among primary schoolchildren. We hypothesized that children who were exposed to the social network-based intervention would report an increase in their water consumption (H1), a decrease in their SSBs consumption (H2), and have stronger intentions to drink water (H3) over time compared to those who were not exposed to the intervention.

1. Method

1.1. Design

The study was a randomized control trial with schools as the unit of randomization. The schools were assigned randomly to either the "Share H_2O" intervention (social network-based intervention) or the control condition (no intervention) by an independent researcher. The "Share H_2O" intervention consisted of exposing the children to influence agents from their own classroom. Children in the control condition did not receive any intervention. All children completed the same pre- and post-intervention measures.

Power calculations were conducted using the program G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009). To detect a small to medium effect (Valente et al., 2003) using a MANCOVA: repeated measures within-between interaction ($f = 0.20$) with two groups and two measurements, 199 participants were needed (power = 0.80, $p = 0.05$). In order to take attrition into account, a larger number of students were recruited.

1.2. Participants

The participants were recruited through their primary schools. Twenty-nine urban and suburban primary schools in the Netherlands were invited to participate. Schools were eligible for participation if they were not involved in any water stimulation program. Ten schools expressed interest in participating; however, six of these were unable to participate due to difficulties scheduling the study. All schools participating in the study included more than 95% of children with a Dutch or West-European background. After gaining active consent from the headmasters of the schools, passive consent was obtained from the children's caretakers (i.e., the caretakers were informed about the study and could withdraw their child from participating). Out of 255 children, 9 (4%) caretakers withdrew their child from the study. At the outset of the study, we obtained informed consent from children. All children who were present at the baseline measurement ($N = 243$) agreed to participate.

As shown in Fig. 1, the schools allocated to the intervention condition included 144 children versus 111 children in the control schools. Of these, 243 (95%) children provided baseline data ($n = 134$ intervention, $n = 109$ control). Five children (4%) in the intervention schools and five (5%) in the control schools did not complete the post-intervention questionnaire. The reason for attrition was children being absent from school on the day of testing. In addition, an entire class ($n = 23$) in the intervention condition was excluded from the analysis, because the teacher undermined the study and discouraged the children to participate seriously. Thus, the final sample consisted of 210 children (52%

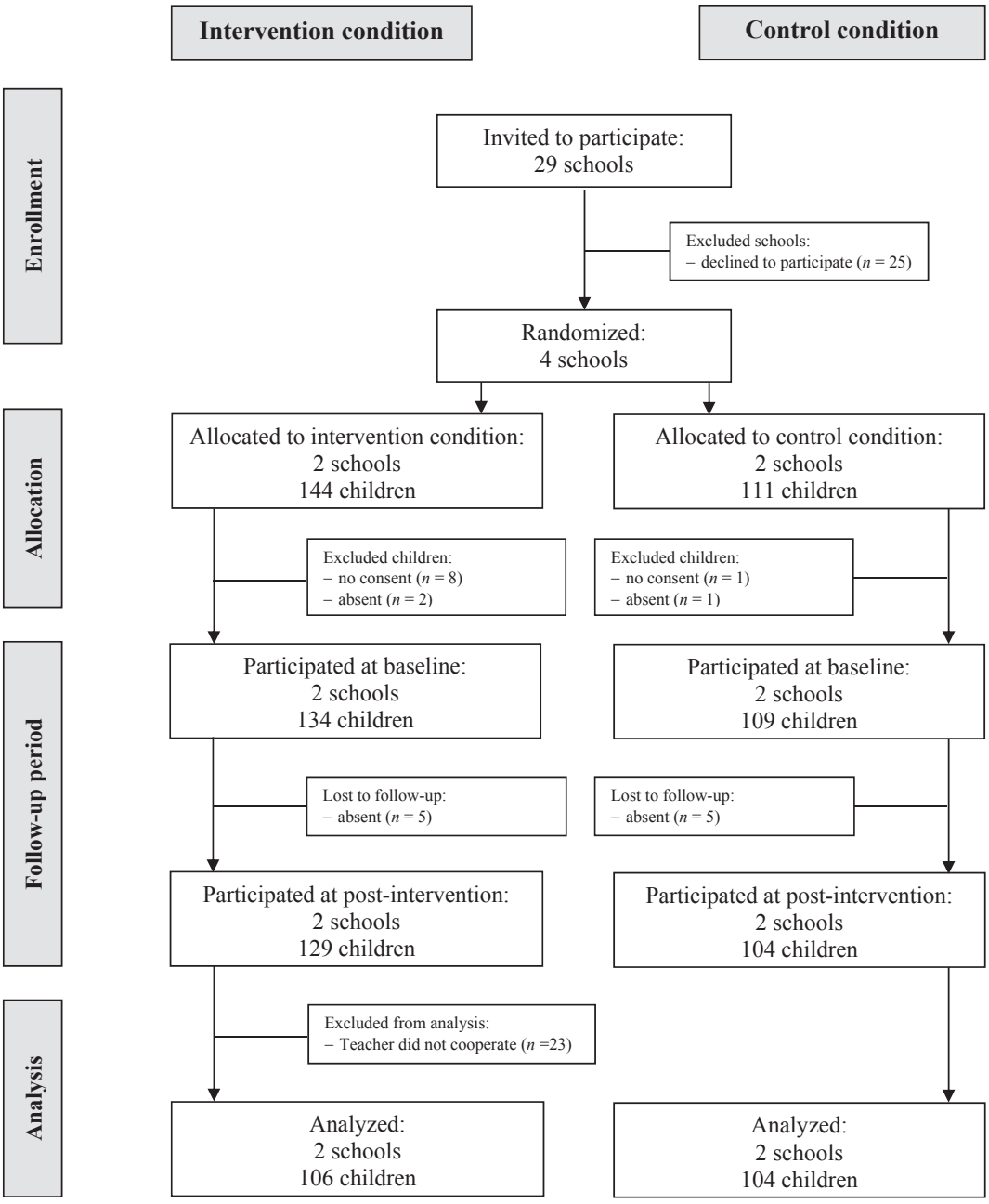

Fig. 1. CONSORT flow diagram of participants.

girls) between 9 and 13 years old ($M = 10.75$ years $\pm$ $SD = 0.80$). Of these children, 104 (52% girls) were in the control condition and 106 children (52% girls) in the intervention condition. A total of 25 children from the five intervention classes were trained as influence agents. This resulted in a mean of 5 influence agents ($SD = 1.41$) per class.

The study was approved by the ethical committee of the Faculty of Social Sciences, Radboud University, Nijmegen, the Netherlands. The study is registered at the Australian New Zealand Clinical Trials Registry: ACTRN12614001179628.

1.3. Setting and procedure

The study took place from January through March 2014 and lasted for a total of nine weeks (baseline measurements were taken in the first week, followed by the intervention during the following eight weeks). Prior to the intervention, all children completed the baseline questionnaire at their schools concerning their consumption behaviors and other factors related to water drinking. Along with the baseline questionnaire, the children completed sociometric questions to identify the influential peers by means of peer nominations. Identical measures were assessed eight weeks after the intervention was started. In the post-intervention questionnaire, children were asked to give a description of the aim of the study. Most children wrote down an aim in line with or related to water consumption. None of the children – except the influence agents – indicated that the study was an intervention using the power of peer influence to promote water consumption.

1.4. Share H_2O intervention training

Researchers delivered the training of the influence agents during school hours in one session that lasted 90 min. The aim of the training was to give influence agents the knowledge and skills to promote water consumption within their social networks. More specifically, the objectives of the training were: (1) to emphasize the benefits of water, (2) to encourage influence agents to consume more water themselves, and (3) to teach them how they could promote water consumption within their social networks. To assess the influence agents' current knowledge about the health and environmental benefits of water drinking, the training started by making a word web. Afterwards, the researchers highlighted the benefits of water and also showed a short movie-fragment about the problems for animals associated with the Great Pacific garbage patch. One way to reduce this garbage patch is by drinking tap water from reusable bottles.

Based on self-persuasion theory (Aronson, 1999), the influence agents were then asked to generate arguments on how to consume more water themselves (Miller & Wozniak, 2001; Mussweiler & Neumann, 2000). After that, their role as influence agent was explained and they were asked whether they were willing to take on this role. All children accepted this role. The influence agents were then asked to think about possible ways through which they could promote water consumption among their peers. From these options, drinking more water themselves and spreading the health and environmental benefits of water were discussed explicitly. Based on the insights of self-determination theory (Deci & Ryan, 1985; Soenens & Vansteenkiste, 2010) it was emphasized that the influence agents should decide for themselves how they wished to encourage their peers to drink more water. In addition, they received a reusable water bottle to stimulate water consumption among their peers.

Two follow-up sessions (one and four weeks after the training) provided researchers the opportunity to offer visible support, resolve any problems that the influence agents experienced in their role, and refresh the information that was discussed in the initial training.

1.5. Measures

1.5.1. Sociometric questions

Five peer nomination items were used to identify the most influential children in each classroom. The children were asked to nominate up to five classmates whom they "respected", "wanted to be like", "looked up to", "went to for advice", and "regarded as good leaders" (Campbell et al., 2008; Starkey, Audrey, Holliday, Moore, & Campbell, 2009). In the intervention schools, children who received the most nominations were trained as influence agents to promote water consumption within their social networks for eight weeks. To ensure gender balance in proportion to the composition of the class, 15% of boys and 15% of girls with the most nominations over all questions were selected (Campbell et al., 2008; Starkey et al., 2009).

1.5.2. Water consumption

At baseline and immediately after the intervention, children were asked to report how much water they drank on a school day and on a weekend day (Haerens et al., 2008). Response categories ranged from 0 = *zero glasses per day* to 5 = *five glasses per day*. Glasses also equaled cans, bottles, and packages. A total score for water consumption was constructed by averaging the school and weekend day items, which demonstrated good internal consistency (Spearman-Brown$_{baseline}$ = 0.83; Spearman-Brown$_{post\text{-}intervention}$ = 0.86).

1.5.3. Sugar-sweetened beverage consumption

The consumption of sugar-sweetened beverages (SSBs) was measured by asking children at baseline and post-intervention to indicate on the same 6-point scale, ranging from 0 = *zero glasses per day* to 5 = *five glasses per day*, how many glasses of juice they drank on a school day and on a weekend day. The same questions were asked for soda and energy drinks (Haerens et al., 2008). A score for SSB consumption was constructed by averaging the six items, which demonstrated acceptable internal consistency (Cronbach's alpha$_{baseline}$ = 0.69; Cronbach's alpha$_{post\text{-}intervention}$ = 0.65).

1.5.4. Water drinking intentions

Behavioral intentions were measured at baseline and post-intervention with a scale on soda beverages (Kassem, Lee, Modeste, & Johnston, 2003) adjusted to water consumption: "Do you intend to drink more water on schooldays?" and "Do you intend to drink more water on weekend days?". Response categories ranged from 1 = *no, certainly not* to 4 = *yes, for sure*. A total score for water drinking intentions was constructed by averaging the school and weekend day items, which demonstrated good internal consistency (Spearman-Brown$_{baseline}$ = 0.76; Spearman-Brown$_{post\text{-}intervention}$ = 0.78).

1.5.5. Thirst

In line with previous research on consumption behavior and the role of hunger status (e.g., Bevelander, Anschütz, & Engels, 2012), the children were asked how thirsty they were at the time they filled in the baseline and post-intervention questionnaire. The children had to indicate how thirsty they were at that moment on a 4-point scale, ranging from 1 = *not thirsty at all* to 4 = *very thirsty*.

1.6. Statistical analysis

Data were analyzed using SPSS version 21 (SPSS, Inc., Chicago, IL, US). Alpha was set at $p < 0.05$. First, independent-samples *t*-tests and Pearson's chi square test were performed to examine whether the randomization resulted in a balanced distribution across the control and intervention condition. To determine whether we had to control for age, sex, and thirst in the main analysis, Pearson's correlations were performed for these variables with water consumption, SSB consumption, and water drinking intentions. For the main analyses, we used a two-way repeated measure MANCOVA with time (baseline vs. post-intervention) and condition (intervention vs. control) as the independent variables and three dependent variables: water consumption, SSB consumption, and water drinking intentions. Statistically significant main effects on condition or time, or an interaction between time and condition on water drinking, SSB consumption, and water drinking intentions were further examined by contrast comparisons or pairwise comparisons with Bonferroni correction. The same analyses were repeated without the influence agents to examine whether the effect of the intervention was driven by the behaviors and intentions of the influence agents. Furthermore, paired sample *t*-tests were carried out to explore the effect of the training on the water and SSB consumption and water drinking intentions of the influence agents. Effect sizes for the *F*-tests were expressed as partial eta-squared ($p\eta^2$) and interpreted as small, medium, and large based on the values 0.01, 0.06, and 0.14, respectively (Stevens, 2009).

2. Results

2.1. Randomization check

To check whether there were differences between the control

and intervention condition on age, thirst, water consumption, SSB consumption, and water drinking intentions independent-samples *t*-tests were conducted. Pearson's chi square tests were performed to check whether there were differences in sex. Table 1 summarizes the means and standard deviations (SDs) for all variables across the conditions. No differences ($p > 0.05$) were found between the intervention and control condition, which indicated that the randomization was successful.

2.2. Main analysis

Pearson's correlation analyses with all the dependent variables in the overall sample showed that thirst correlated significantly at both baseline and post-intervention with water consumption ($r_{baseline} = 0.27$, $p < 0.001$; $r_{post\text{-}intervention} = 0.23$, $p = 0.001$) and water drinking intentions ($r_{baseline} = 0.15$, $p = 0.032$; $r_{post\text{-}intervention} = 0.23$, $p = 0.001$). However, thirst only correlated marginally significant with SSB consumption at post-intervention ($r_{baseline} = 0.09$, $p = 0.199$; $r_{post\text{-}intervention} = 0.13$, $p = 0.052$). This was not the case for age and sex ($p > 0.05$). To make sure that thirst did not confound the effects, we included thirst at both time points as covariates in the main analysis.

To examine whether children in the intervention condition reported consuming more water, less SSBs, and stronger intentions to drink water post-intervention, compared to those in the control condition, a two-way repeated measures MANCOVA was performed. There was a significant multivariate interaction effect between condition and time ($V = 0.07$, $F(3,204) = 5.18$, $p = 0.002$, $p\eta^2 = 0.07$) on the dependent variables. Furthermore, the model showed a significant multivariate main effect across condition (regardless of time points) ($V = 0.04$, $F(3,204) = 2.99$, $p = 0.032$, $p\eta^2 = 0.04$) on the three dependent variables, but not across time (regardless of condition) ($V = 0.02$, $F(3,204) = 1.06$, $p = 0.367$). In addition, the covariates thirst at baseline and post-intervention had a significant effect on the dependent variables ($V = 0.05$, $F(3,204) = 3.74$, $p = 0.012$, $p\eta^2 = 0.05$; $V = 0.05$, $F(3,204) = 3.43$, $p = 0.018$, $p\eta^2 = 0.05$, respectively). Further interpretation of the multivariate interaction effect between condition and time are presented below in the univariate outcomes of the multivariate model adjusting for thirst.

2.2.1. Water consumption

There was a significant main effect for condition ($F(1,206) = 7.59$, $p = 0.006$, $p\eta^2 = 0.04$), but not for time ($F(1,206) = 0.16$, $p = 0.689$) on water consumption. More importantly, there was a significant interaction effect between condition and time ($F(1,206) = 5.41$, $p = 0.021$, $p\eta^2 = 0.03$) on water consumption, indicating that changes in water consumption differed for children in the intervention and control conditions. Posthoc contrast comparisons showed a significant difference in water consumption over time for the intervention condition ($M_{baseline} = 2.67 \pm SEM\ 0.13$; $M_{post\text{-}intervention} = 2.92 \pm SEM\ 0.14$; $p = 0.018$), but not for the control condition ($M_{baseline} = 2.37 \pm SEM\ 0.13$; $M_{post\text{-}intervention} = 2.27 \pm SEM\ 0.14$; $p = 0.360$). This means that children who were exposed to the social network-based intervention reported a significant increase in their water drinking compared to the children who were not exposed to the intervention.

2.2.2. Sugar-sweetened beverage consumption

There were no significant main effects for condition ($F(1,206) = 0.003$, $p = 0.957$) or time ($F(1,206) = 2.46$, $p = 0.118$); but a significant interaction effect between condition and time ($F(1,206) = 6.08$, $p = 0.015$, $p\eta^2 = 0.03$) on SSB consumption. This indicates that changes in SSB consumption differed for children in the intervention and control conditions.[1] Posthoc contrast comparisons showed a significant difference in SSB consumption over time for the intervention condition ($M_{baseline} = 1.28 \pm SEM\ 0.07$; $M_{post\text{-}intervention} = 1.06 \pm SEM\ 0.06$; $p < 0.001$), but not for the control condition ($M_{baseline} = 1.18 \pm SEM\ 0.07$; $M_{post\text{-}intervention} = 1.15 \pm SEM\ 0.06$; $p = 0.596$). This indicates that children who were exposed to the social network-based intervention reported drinking significantly less SSB over time than children who were not exposed to the intervention.

2.2.3. Water drinking intentions

There was a marginal significant main effect for condition ($F(1,206) = 3.34$, $p = 0.069$, $p\eta^2 = 0.02$) and no significant main effect for time ($F(1,206) = 0.56$, $p = 0.454$) on water drinking intentions. More importantly, there was a significant interaction effect between condition and time ($F(1,206) = 3.93$, $p = 0.049$, $p\eta^2 = 0.02$) on water drinking intentions, indicating that changes in water drinking intentions differed for children in the intervention and control conditions. Posthoc contrast comparisons showed a significant difference in water drinking intentions over time for the control condition ($M_{baseline} = 2.75 \pm SEM\ 0.07$; $M_{post\text{-}}$

Table 1
Randomization checks of the variables measured by control and intervention condition[a].

	Intervention ($n = 106$)	Control ($n = 104$)	p-value[b]
Age (y)	10.67 ± 0.78 9–13	10.83 ± 0.82 9–13	0.155
Boys/girls (n/n)	51/55	50/54	0.996
Thirst	2.11 ± 0.79 1.00–4.00	2.09 ± 0.73 1.00–4.00	0.799
Water consumption	2.67 ± 1.40 0.00–5.00	2.37 ± 1.39 0.00–5.00	0.110
SSB consumption	1.28 ± 0.84 0.17–5.00	1.18 ± 0.60 0.17–2.83	0.302
Water drinking intentions	2.83 ± 0.75 1.00–4.00	2.75 ± 0.74 1.00–4.00	0.493

Note.
[a] Values are presented in means ± SDs, min.–max.
[b] Reflects the differences in means between the conditions by independent-samples *t*-tests or Pearson's chi square test.

[1] The SSB consumption measure at both baseline and post-intervention were positively skewed. However, the results were identical when using the raw and logarithmically transformed scores; therefore, the reported analyses are based on the raw scores.

$_{intervention}$ = 2.60 ± *SEM* 0.07; $p = 0.026$), but not for the experimental condition ($M_{baseline}$ = 2.83 ± *SEM* 0.07; $M_{post\text{-}intervention}$ = 2.86 ± *SEM* 0.07; $p = 0.576$). The findings indicated that children who were exposed to the intervention did not report a change in their water drinking intentions over time, whereas the children in the control condition reported a decrease in their water drinking intentions.

2.3. Additional analyses

The same analyses were performed in the sample excluding the influence agents ($n = 185$) to investigate whether the effect of the intervention was driven by the behavior and intentions of the influence agents. Similar results were found for the multivariate model, with a significant interaction effect between condition and time ($V = 0.06$, $F(3,179) = 3.89$, $p = 0.010$, $p\eta^2 = 0.06$) on the three dependent variables and marginal significant main effects for condition and time ($p = 0.086$ and $p = 0.092$, respectively). The univariate outcomes of the multivariate model showed weaker but comparable findings. Significant and marginal significant interaction effects were found between condition and time on water drinking ($F(1,181) = 3.64$, $p = 0.058$, $p\eta^2 = 0.02$), SSB consumption ($F(1,181) = 5.56$, $p = 0.019$, $p\eta^2 = 0.03$) and water drinking intentions ($F(1,181) = 2.81$, $p = 0.095$, $p\eta^2 = 0.02$). For water drinking, posthoc analyses showed that children in the intervention condition reported a marginally significant increase in their water consumption over time ($M_{baseline}$ = 2.68 ± *SEM* 0.15; $M_{post\text{-}intervention}$ = 2.90 ± *SEM* 0.16; $p = 0.080$), which was not the case for children in the control condition ($p = 0.376$). For SSB consumption, the children who were exposed to the social network-based intervention reported a significant decrease in their SSB consumption over time ($M_{baseline}$ = 1.34 ± *SEM* 0.08; $M_{post\text{-}intervention}$ = 1.11 ± *SEM* 0.07; $p < 0.001$), but not in the control condition ($p = 0.610$). For water drinking intentions, the children in the control condition reported a significant decrease over time ($M_{baseline}$ = 2.76 ± *SEM* 0.07; $M_{post\text{-}intervention}$ = 2.60 ± *SEM* 0.07; $p = 0.025$). This was not found for the children in the intervention condition ($p = 0.814$).

A paired sample *t*-test was performed to explore the effect of the intervention on the water drinking behaviors and intentions of the influence agents ($n = 25$). The influence agents reported a marginal significant increase in their water consumption ($M_{baseline}$ = 2.64 ± *SEM* 0.28; $M_{post\text{-}intervention}$ = 3.00 ± *SEM* 0.27; $p = 0.056$) and a marginally significant decrease in their SSB consumption over time ($M_{baseline}$ = 1.10 ± *SEM* 0.13; $M_{post\text{-}intervention}$ = 0.88 ± *SEM* 0.10; $p = 0.071$). The influence agents did not report a significant change in their water drinking intentions over time ($p = 0.540$).

3. Discussion

The intervention "Share H_2O" aimed to promote water consumption among primary schoolchildren by exposing children to influence agents from their own classroom. In the present pilot study, we tested the effectiveness of this intervention by examining its impact on children's self-reported water drinking behaviors. Consistent with our expectations, the intervention with influence agents encouraging their peers to consume more water resulted in children reporting an increase in their water drinking (H1) and a decrease in their SSB consumption (H2) over time. These findings are in line with the growing body of peer influence research demonstrating that children model the consumption behaviors of their peers (Bevelander et al., 2012; Cruwys et al., 2015). That is, the children could have consumed more or less according to a potential social norm that was set by a peer. Previous studies have shown that encouragement by peers can increase acceptance and consumption of foods (Hendy, 2002; Hendy & Raudenbush, 2000) and even seeing peers consume food children do not like can increase their preferences and intake of these foods (Birch, 1980). This could also have been the case in the present study, given the fact that the influence agents successfully promoted water consumption which also led to their peers reporting a decrease in their SSB consumption. Nevertheless, we do not know whether children replaced their SSB consumption by drinking (more) water, or that the children who were exposed to the social network-based intervention modeled the influence agents in drinking less SSBs. Further research is needed to unravel by which of these mechanisms the decrease of SSB consumption could be explained.

Notably, this was the first intervention study aimed at water drinking that incorporated the social modeling mechanism in conjunction with peer status among primary school children. The findings suggest that it is important to take the status of peers into account when targeting behavioral change processes in social networks. Previous experimental studies in adolescents have shown similar effects of peers on alcohol consumption (Larsen, Engels, Souren, Granic, & Overbeek, 2010; Teunissen et al., 2012), where high status peers were more influential than low status peers in reducing their willingness to drink alcoholic beverages (Teunissen et al., 2012). The adolescents accepted and internalized the anti-alcohol norms of their popular peers (Teunissen et al., 2012). This could also have been the case in the present study, however, we can only speculate whether the selected influence agents were more influential in improving children's water consumption behaviors. Nevertheless, the children in the intervention reported an increase in their water drinking and a decrease in their SSB consumption compared to the children in the control conditions. Future research should investigate the status of peers into more detail.

Contrary to expectations, the children exposed to the social network-based intervention did not report a change in their intentions (H3). There are several explanations for the stability (instead of an increase) in water drinking intentions in the intervention condition. First, it might be that the children modeled the drinking behavior of their peers unconsciously, while self-reported intentions require being conscious of one's behavior and plans (Cruwys et al., 2015; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). Research has shown that children follow the food intake behavior of their peers, even after being told explicitly what social modeling behavior is and having practiced social influence situations (Bevelander, Engels, Anschutz, & Wansink, 2013). We acknowledge that this does not explain why the influence agents maintained (rather than increased) their water drinking intentions, given they were the ones who were being modeled. A possible explanation might be that the influence agents were not able to report greater water drinking intentions, because they already consumed more water. A second explanation for the stability in the children's intentions might be that measuring an individual's intention to change might not provide a complete picture of actual behavior change (Sheeran, 2002; Sniehotta, Scholz, & Schwarzer, 2005). To explain this discrepancy between intention and behavior other possible mediators must be examined (Sniehotta et al., 2005).

Additionally, we found that the nonexposed children reported a decrease in their water drinking intentions over time. This significant decrease in water drinking intentions could have been caused by frustration resulted from asking the nonexposed children about their intentions for a second time. Unlike the children in the intervention condition, the nonexposed children were not motivated to uphold their opinion towards water, which might explain why the decrease was only observed in the control condition.

Furthermore, it is important to note that this study was the first

that incorporated self-persuasion theory (i.e., motivating individuals to persuade themselves; Aronson, 1999; Miller & Wozniak, 2001; Mussweiler & Neumann, 2000) and the self-determination theory (i.e., supporting the individuals' need for autonomy by providing choices; Deci & Ryan, 1985; Soenens & Vansteenkiste, 2010) in the training of the influence agents. It might be the case that if the influence agents were not asked whether they actually would like to take on this role, that they may have felt that the role of an influence agent was imposed on them. This could have led to them not promoting the desired behaviors, because drinking water is presumably not considered a popular beverage among this age group (Drewnowski et al., 2013). Reactance might have occurred (Brehm, 2009), leading the influence agents to reject water drinking as beneficial. Our findings suggest that the training influenced them positively, given the reported increase in their water consumption. Nevertheless, these explanations remain speculative and future research is necessary to examine whether the training increased influence agents' intrinsic motivation and level of self-persuasion immediately after the training. However, it is important to note that, overall, the influence agents reacted enthusiastically at the end of the training and expressed their willingness to help make drinking water a trend.

Some limitations should be addressed in interpreting the findings of this pilot study. First, although the reported increase in water consumption (and decrease in SSB consumption) was significant, it is important to mention that the found effects were small – with an average increase of water consumption of less than half a serving. Related to this, beverage consumption was assessed by self-report measures only. An additional methodology would have been to use a more direct measurement, such as the use of flow meters attached to the schools' water fountains to determine the amount of water dispensed from these fountains (Loughridge & Barratt, 2005). Unfortunately, this was not possible in our study. Future studies should seek to replicate our findings using additional means to evaluate beverages consumption. Second, the sample was relatively small, future research is needed to replicate this study in a larger and more diverse sample. This is especially important when it comes to analyzing the data without the influence agents. Third, and related to the previous point, it is important to disentangle the effect from the training itself from the effect of the influence agents encouraging their peers to drink water. An approach for this could be to compare the impact of the training delivered to the whole network to delivering the training to the influence agents (as was done in the current study).

Fourth, we focused only on short-term effects of the intervention. Although the results of this study are promising for improving children's consumption behaviors, a next step would be to replicate this study and to include follow-up assessments to examine potential long-term effects. Finally, our study identified the influential peers by means of five questions about respect, good leadership, identification, and advice seeking. It might be that various peers are influential in different ways with regard to specific behaviors. For example, a child might function as a role model with regard to water consumption, but not with regard to eating healthy, physical activity, smoking, or drug use. In order to fully understand the role of influence agents in health interventions, future research should continue to explore the different types of characteristics (e.g., social status; Rogers, 2003) or personality traits (e.g., self-esteem; Bevelander, Anschütz, Creemers, Kleinjan, & Engels, 2013) that make some individuals more influential than others. For health professionals it is highly relevant to know which characteristics are most important for positive health behavior change among children.

In conclusion, the present pilot study was the first intervention study aimed at water drinking that incorporated the social modeling mechanism in conjunction with peer status among primary school children. Findings showed that a social network-based intervention stimulating peer influence on water consumption is a very promising method to improve children's drinking behaviors. Our findings underline the importance of peers and the social context for health interventions, suggesting a promising avenue for future interventions and intervention research. In addition, we found that a sole focus on promoting water can not only increase children's self-reported water consumption, but also reduce their SSB consumption.

Conflict of interest statement

All authors of this paper reported no conflicts of interest.

Financial disclosure

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Author contributions

CRS, RNHL, WJB, and MB conceptualized and designed the study; CRS and RNHL designed and provided the training; CRS collected the data; CRS, KEB, and WJB analyzed the data; CRS wrote the paper; RNHL, KEB, WJB, and MB critically reviewed the manuscript.

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