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Increasing water intake in pre-school children with unhealthy drinking habits: a year-long controlled longitudinal field experiment assessing the impact of information, water affordance, and social regulation

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Abstract

Objective: We investigated the effect of three interventions to increase the plain water consumption of children with unhealthy drinking habits, with an innovative approach combining the three layers of Installation Theory: embodied competences, affordances and social regulation.

Methods: 334 preschool children and their carers were allocated to three interventions: *Control* (CONTROL): no intervention, *Information* (INFO): online coaching sessions on water health benefits aiming at modifying embodied competences (knowledge), *Information + Water Affordance* (INFO+W): the same plus home delivery of small bottles of water. After three months, half of the INFO and INFO+W subjects were allocated to *Social Regulation* (+SOCIAL) (on-line discussion forum) or no further intervention (-SOCIAL). Intake of plain water and all other fluid types of the children were recorded by the carers 6 times over a year using an online 7-day fluid-specific dietary record.

Results: Over 1 year, all groups significantly increased water consumption by 3.0 to 7.8 times (+118 to +222 mL). INFO+W+SOCIAL and INFO-SOCIAL generated the highest increase in plain water intake after one year compared to baseline, by 7.8 times (+216 mL) and 6.7 times (+222 mL) respectively; both significantly exceeded the CONTROL (3.0 times, +118 mL), whilst the effect of INFO+W-SOCIAL (5.0 times, +158 mL) and INFO+SOCIAL (5.3 times, +198 mL) did not differ from that of CONTROL. All groups saw a decrease of sweetened beverages intake, again with INFO+W+SOCIAL generating the largest decrease (-27%; -172 mL). No changes in other fluids or total fluid intake were observed.

Conclusions: Sustainable increased water consumption can be achieved in children with unhealthy drinking habits by influencing representations, changing material affordances, and providing social regulation. Combining the three provided the strongest effect as predicted by Installation Theory.

Key words: water intake; field experiment; behaviour change; Installation Theory; children; intervention.

Abbreviations: BMI: body mass index; DRIs: Dietary Reference Intakes; EFSA: European Food Safety Authority; IOM: Institute of Medicine; SSB: sugar-sweetened beverages; TFI: total fluid intake; TWI: total water intake.

Introduction

Young children in many countries currently drink less water than is healthy. Children obtain most of their water intake from fluid intake. The European Food Safety Authority (EFSA) and the Institute of Medicine (IOM) estimated that 70-80% of total water intake comes from total fluid intake (TFI, intake of plain water and all other beverages) and 20-30% of water from food moisture (EFSA Panel on Dietetic Products Nutrition and Allergies (NDA), 2010; Institute of Medicine & Food and Nutrition Board, 2004). Harmonized cross-sectional surveys performed in 13 countries showed that up to 90% of children aged 4 to 9 years obtained less than an adequate intake of water from fluids (Guelinckx, Iglesia, et al., 2015; Iglesia, et al., 2015). In a study of US children aged 4 to 8 years, at least 75% of children failed to meet the adequate total water intake (Drewnowski, Rehm, & Constant, 2013). As a consequence, there are good reasons to seek interventions that might increase children's water intake. As indicated by EFSA, reaching an adequate intake can best be amended by increasing the intake of preferably energy-free beverages (e.g. drinking water(EFSA Panel on Dietetic Products Nutrition and Allergies (NDA), 2010). Indeed, the average intake of plain water was only 651 (535) and 661 (525) mL in boys and girls respectively in the previously cited surveys (Guelinckx, Iglesia-Altaba, et al., 2015). In another review, the contribution of plain water to TFI in children ranged from only 21 to 58%, and varied greatly between countries (Ozen, Bibiloni Mdel, Pons, & Tur, 2015). Over the long-term, children need sufficient hydration for healthy development. Depleted hydration correlates with poorer cognitive performance, which is ameliorated by short-term increases in hydration (Edmonds & Burford, 2009; Edmonds & Jeffers, 2009), though the precise extrapolation from the impact of short-term interventions to consistent, long-term changes in fluid balance is not certain. Indeed, the specific mechanisms which lead children to benefit from drinking water are also as yet unknown. However, regardless of these issues concerning the nature and impact of hydration, many children currently typically drink too little water and so methods for encouraging longer-term changes of their water drinking habits require investigation. This is the focus of our study.

Changing habits including water intake is, however, not a trivial task. Interventions policies are usually based on education and information, because these are well suited to large scale campaigns, even though local contextual factors may be equally relevant in habit formation and continuance. Strong evidence indicates that behavior change interventions should be multi-level, addressing the individual *and* their environment (Huang, Drewnosksi, Kumanyika, & Glass, 2009). Installation Theory claims that generating behavioral changes that become sustainable habits often involves behaviors being nudged and supported at three different levels: environmental affordances, embodied competences (knowledge, know-how, capacities) and social regulation (Lahlou, in press). The second and third levels are usually addressed by providing information about the benefits of the intended change (e.g. health campaigns) because this is an easy way to address large populations, and the most popular social psychological models of behavior and behavior change focus on attitudes, beliefs and norms within the individual (see Darnton, 2008 for a review of such models). However, it has long been known that such approaches alone may not generate marked or sustained behavioral changes, especially regarding eating (Lewin, 1943). Arguably, behaviors may be cued *directly* by specific aspects of the environment, via affordances or connotations of activity (Uexküll, 1934), without mediation by attitudes or explicit beliefs (e.g. water evokes drinking). Finally, significant goals and habits are rarely acquired or maintained alone, but require 'scaffolding' and support for control by social, familial and educational settings (e.g., Voyer & Franks, 2014). Other people can provide cues to action, direction, act as role models, and offer positive or negative feedback. Community membership may thus encourage habit formation by, for example, desire to conform, explicit goal sharing or by implicit goal contagion (Aarts, Gollwitzer, & Hassin, 2004; Dik & Aarts, 2007; Loersch, Aarts, Payne, & Jefferis, 2008). Children especially are dependent on social context for acquiring habits, in two principal ways. First, they have no choice but to be socialized in their family and its 'installations" (including home environment, routines, local rules and values) become the default, "normal" conditions. Second, they are highly attuned to family, peer and other social influences in acquiring goals, motivations and plans that contribute to habit formation (Avery, Bostock, & McCullough, 2015). Other people, in particular carers, are essential sources of the child's consumption goals, plans and intentions, with a significant impact on their health outcomes (Connell & Francis, 2014; Janicke, 2013). In line with our approach, a recent "toolkit" for "how to promote water intake at school" provided by the European Commission's Joint Research Center, has highlighted that interventions with multiple components (combining educational, environmental and parental elements) are more likely to be effective (European Commission, 2016).

In children, intervention studies showing successful sustainable increases in water intake are scarce. First, many intervention studies have targeted water and SSB (sugar sweetened beverage) intake as part of a general nutritional intervention program, making it difficult to assess the contribution of each component to the success of the intervention (Beech, et al., 2003; James, Thomas, Cavan, & Kerr, 2004; Kaufman-Shriqui, et al., 2016; Sichieri, Paula Trotte, de Souza, & Veiga, 2009). Second, most studies aim to increase water intake as a means to reduce body weight or body mass index (BMI) or to prevent weight gain in children (Muckelbauer, et al., 2009; Schwartz, Leardo, Aneja, & Elbel, 2016). While reducing obesity prevalence or preventing weight gain is a valuable aim, increasing water intake as an end *per se* is of important given the aforementioned potential consequences of inadequate hydration on cognitive performances. Third, most intervention studies focus on the school environment (Beech, et al., 2003; James, et al., 2004; Muckelbauer, et al., 2009; Schwartz, et al., 2016; Sichieri, et al., 2009) although parents and/or carers play an essential role in habit formation in children. For example, for the majority of children, sweet beverage consumption (60-80% of the calorific intake for beverages) happens at home (Wang, Ludwig, Sonneville, & Gortmaker, 2009). Home-based interventions, whilst less common, may promote larger and more sustainable changes (Avery, et al., 2015), and may moreover generate changes in parental consumption, further reinforcing children's healthy consumption in a cyclical manner (Anderson, Symoniak, & Epstein, 2014; Lahlou, Boesen-Mariani, Franks, & Guelinckx, 2015). For this reason, children's habit-formation should be assessed not just 'in the field' in a general way, but specifically in its familial, social, and community setting.

The aim of study was to assess the utility of different kinds of interventions on plain water intake of children. A longitudinal field experiment was therefore set up based on the three levels of the home installation for drinking behavior: embodied interpretive systems (providing information), affordances of the environment (water affordance), and social regulation (influence of the community) . Our hypothesis was that, although each of the interventions would trigger increased plain water intake, combining all three together would be most successful at changing habits sustainably; we were especially interested at assessing the relative effect of these levels and their combination. We had no specific expectations for changes in TFI, nor for changes in SSB consumption. An increase in plain water intake might arise from an increase in TFI and no change in SSB intake, or from a consistent TFI in which plain water was substituted for SSBs.

Methods

Sample

This controlled longitudinal year-long study was set in Poland, where around 50% of 3-6 year olds drink more than 800 ml of sweet beverages, less than 150ml per day of water, and fail by far to meet EFSA dietary reference values for TWI. The study took place between 2012 and 2013. The protocol fulfilled British Psychological Society ethical guidelines, was approved by the Research Ethics Committee of the Social Psychology Department at London School of Economics and the Bioethics Committee at the Institute of Food and Nutrition in Warsaw. Households were tracked over 12 months and received a small reward for participation (a kitchen set worth 40 Euros).

Recruitment

Households were recruited by telephone following representativeness quotas on age, socio-economic categories, and household size in eight Polish cities (Bydgoszcz, Gdańsk, Lublin, Łódź, Katowice, Kraków, Poznań, Warszawa). Only one child was recruited in each household. If two or more children were eligible in one household, the child was selected to complete the less filled quota at the time of selection. The recruitment phase was completed in May 2012. All carers gave written informed consent prior to the start of the study. Eligible children were 3 to 6 years old with no medical conditions possibly contributing to hyper- or hypo-consumption of water. Children were eligible if they drank low quantities of water per day (maximum 250 mL of plain water per day, including tap, still, or carbonated) and high quantities of sweet beverages (minimum 800 mL per day). These cut offs were based on mean intakes observed in a cross-sectional survey among Polish children, adolescents and adults performed in 2010 and 2014, which had as a primary objective to assess fluid intake in representative samples (unpublished data). To verify selection criteria, a fluid consumption questionnaire was completed during the screening visit. A second verification was based on the results of the first 7-day fluid-specific dietary record completed at baseline. A total of 439 households were eligible for the study. Parents or carers had main responsibility for the child's nutrition and presented no relevant medical condition.

Study design

The study design is presented in figure 1. At the beginning of the study, following baseline data collection, households were allocated to three different initial interventions lasting three weeks: *Control* (CONTROL) with no experimental intervention, *Information* (INFO) with carers attending 6 online sessions, *Information + Water Affordance* (INFO+W) with carers attending the same online sessions and receiving water at home for the children. Around 4 months (17 weeks) after the end of this first intervention, INFO and INFO+W groups were each divided into two subgroups: one subgroup from each was allocated to a *Social Regulation* condition (+SOCIAL) while the other had no further intervention (-SOCIAL). Carers in the +SOCIAL group were invited to join a community online discussion forum for 3 weeks in September. The INFO group was thus divided into INFO+SOCIAL and INFO-SOCIAL; INFO+W was divided into INFO+W+SOCIAL and INFO+W-SOCIAL. CONTROL; INFO-SOCIAL and INFO+W-SOCIAL received no additional input. Some comments on this design are necessary here. First the control group is in all scientific rigor inevitably an intervention group since the very fact of measuring (here, fluid intake) is itself an intervention. Second, the combination of conditions was designed to make sense for the participants and produce realistic results usable for public policies: hence the INFO condition as a start for all the non-control conditions, since any real-world intervention would in practice require some explanations –bringing in bottles or asking people to participate in online communities without explanation would lack ecological validity.

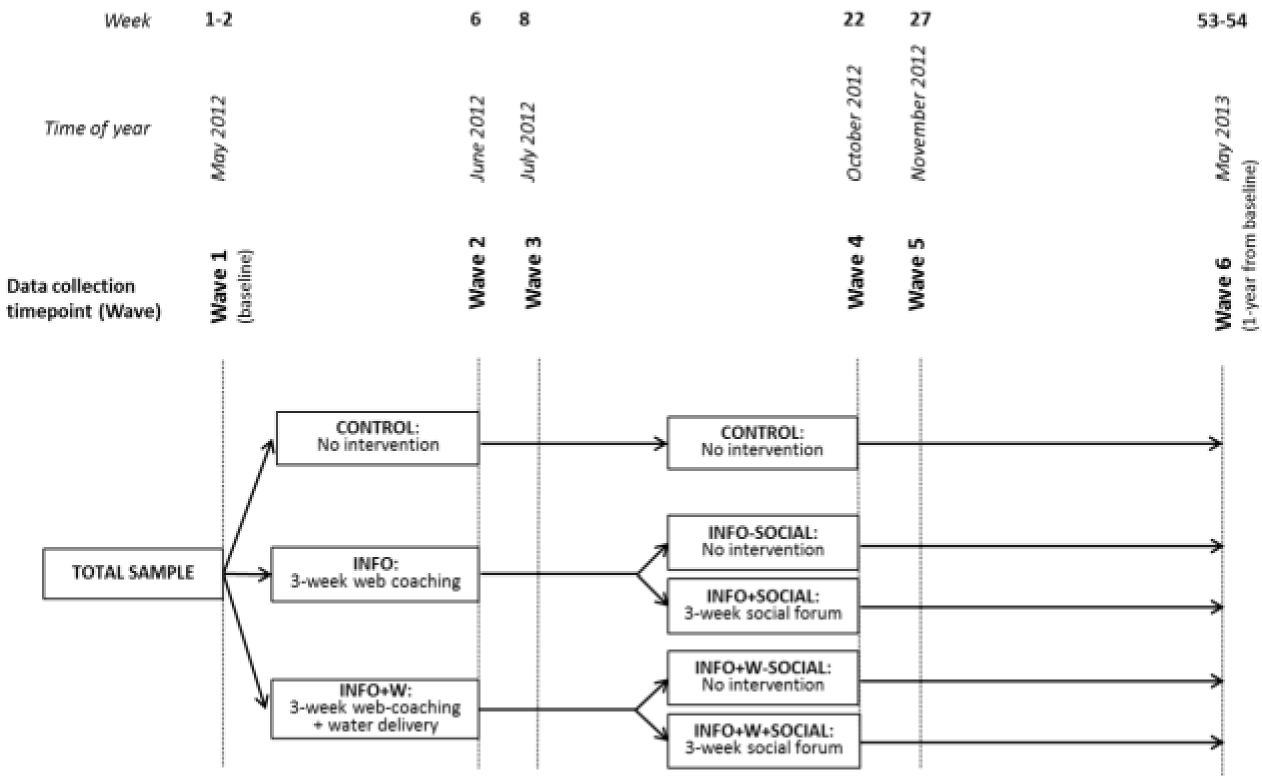

Figure 1. Study design

Data collection was completed in six 'waves' described in Figure 1: Wave 1 (baseline, week 1 and 2, May 2012); Wave 2 (immediately after 3-week intervention, week 6, June 2012); Wave 3 (following a 2-week wash-out after intervention, week 8, July 2012); Wave 4 (immediately after 3-week online forum, week 22, October 2012); Wave 5 (following a 5-week wash-out after online forum, week 27, November 2012); Wave 6 (one year after the beginning of the intervention, week 53 and 54, May 2013).

Waves 2 and 3 aimed to assess short- and medium-term effects of the initial interventions respectively. Waves 4 and 5 aimed to assess short- and medium-term effects of the social regulation respectively. Wave 6 aimed to assess the long-term effects of all interventions (6 months after they ended). It also enabled us to separate out changes in fluid intake due to seasonal changes, and/or due to child maturation as opposed to our interventions.

Interventions:

In the *Information* condition, participants received 6 online sessions evenly spread over 3 weeks (2 per week) which included a combination of materials such as figures, texts and videos with explicit information about water/beverage intake recommendations for children, how water is assimilated by the body, its influence on physiological and cognitive functions; and offered suggestions for integrating water into their children's routine. In the *Water Affordance* intervention, in addition to the online sessions, water was provided in the household, in small enough bottles specially designed for children to grasp, pick up and open themselves i.e., in culturally appropriate, physically useable form, which offered direct cues and affordances to increase water consumption (in total, 63 bottles of 330 mL per participant over three weeks). In households where more than one 3-6 year old child met the recruitment target, additional water was supplied to cover the needs of all of them, though only one child was a participant in the study; e.g., if the household included 2 such children, the family received double the number of water bottles. The *Social Regulation* condition aimed to mimic the norms and rules of a group by creating an online forum where families could engage in community activities (Gleibs, Haslam, Haslam, & Jones, 2011), discuss ways of increasing water consumption, tips, and develop and share norms.

Measurement of fluid intake

A fluid-specific dietary record was provided to the carers to record fluid intake (water and beverages of all kinds) of their child over 7 consecutive days . This record was previously used and described in publications reporting cross-sectional surveys with large samples of children (Guelinckx, Iglesia, et al., 2015; Iglesia, et al., 2015).The record was completed online. For each drinking occasion, the type and amount of fluid consumed, and the time and the location of consumption were recorded. To help estimate quantities, images of a range of standard containers (e.g. glasses, mugs) with volume equivalent indicators were provided. The fluids were classified into: plain water (tap water, bottled still and carbonated water), milk and milk derivatives, SSBs (carbonated sweet beverages, water with sugar/syrup, fruit non-carbonated drinks, "kompot" (traditional homemade fruit brew), hot beverages containing on average 2 spoons of sugar), alcoholic drinks, and other beverages (Supplementary table S1). The sum of all these categories was defined as TFI .

Sample size

Due to the lack of studies using similar designs, samples, or outcomes, no sample size could be calculated from previous publications and the sample size was therefore estimated. A final sample size of 300 children was decided for the study, and anticipating a drop-out of 30%, a minimal sample of 430 children was recruited into the study . Based on the recruitment timing and research budget, the final recruited sample reached 439 children. This sample size is comparable to other recent nutritional intervention trials aiming to prevent obesity in similar-aged children which also used a multi-component approach combining environmental, educational, and parental aspects and included aspects on water intake (Natale, Lopez-Mitnik, Uhlhorn, Asfour, & Messiah, 2014; Story, et al., 2012). Natale *et al*. aimed to examine the effect of an early childhood obesity prevention program on changes in BMI *z*-score and nutrition practices over 6 months in 307 children aged 2 to 5 years. Story *et al*. aimed to test the effect of a school environment intervention, supplemented with family involvement, on reducing excessive weight gain among 454 kindergarten and first-grade children over 2 years.

Statistical analysis

The general pattern of water intake for each group between wave 1 and 6 was analyzed using MANOVA. Post-hoc Bonferoni pairwise comparisons were used to assess the effect of each intervention between baseline and final measurements. The short- and medium-term effects of *Information* and *Water Affordance* on water intake were analysed by comparing the INFO, INFO+W, and the CONTROL group at wave 2 and 3 using ANOVA. Post-hoc specific comparisons by Fisher's protected LSD were used to compare groups. The short- and medium-term effects of *Social regulation* on water intake were analysed by comparing the 4 intervention groups and the Control group at wave 4 and 5 using ANOVA. Post-hoc specific comparisons by Fisher's protected LSD were used to compare groups. The long-term effects of each intervention on water intake were analyzed by comparing the 4 intervention groups and the Control group at wave 6 using ANOVA. Post-hoc specific comparisons by Fisher's protected LSD were used to compare groups. All statistical tests were done on absolute quantities, not percentage or percentage change.

Results

Sample

By study end, selection, drop-outs, and failures to follow the protocol left a sample of 334 children (76% of the initial sample, Figure 2). The drop out was 22%, 19%, and 18% in the CONTROL, INFO, and INFO+W group respectively . Most of the drop out (76%) happened following baseline data collection and wave 1 due to incompleteness of the questionnaires or failure to meet the sampling criterion on plain water consumption in the second check of the eligibility using the fluid consumption record as described above (Figure 2). The demographic characteristics of the children who dropped out between wave 1 and wave 6 did not differ from those of the overall sample (n=78, age: 3-4 (47%), 5-6 (53%); sex: girls (46%), boys (54%), BMI: normal (65%), underweight (23%), overweight (10%), obese (1%)).

Table 1. Demographic data of the completed sample

Group	n	Sex (%)		Age (%)			BMI (%)			
				-4	-6	mean	normal	under-weight	over-weight	obese
control	61	0	0	8	2	4,5	73	15	13	0
Info	136	8	2	3	7	4,4	62	21	12	5
Info -social	64	0	0	0	0	4,4	75	16	6	3
Info+social	72	6	4	6	4	4,3	51	25	17	7
Info+w	137	1	9	0	0	4,4	68	20	9	2
Info+w-social	65	8	2	2	8	4,4	68	23	8	2
Info+w+social	72	4	6	9	1	4,4	68	18	11	3
TOTAL	334	0	0	1	9	4.4	66	19	11	3

The overall sample was balanced for sex (50% female, 50% male) and age group (51%, 3-4 years; 49%, 5-6 years; mean = 4.44, SD=1.16) (Table 1). Analysis of the BMI *z*-score, calculated based on 2012 growth references for Polish preschool children, showed that 66% of the children were normal weight, while 19%, 11%, and 3% were underweight, overweight, and obese respectively (Kulaga, et al., 2013). The description of each group is presented in Table 1. Most were in two parent families (90%), with parents in the normal BMI range (18-25 kg.m^{-2}) (73%), whose occupational status varied (68% working full-time, 12% working part-time, 18% unemployed or not working for other reasons).

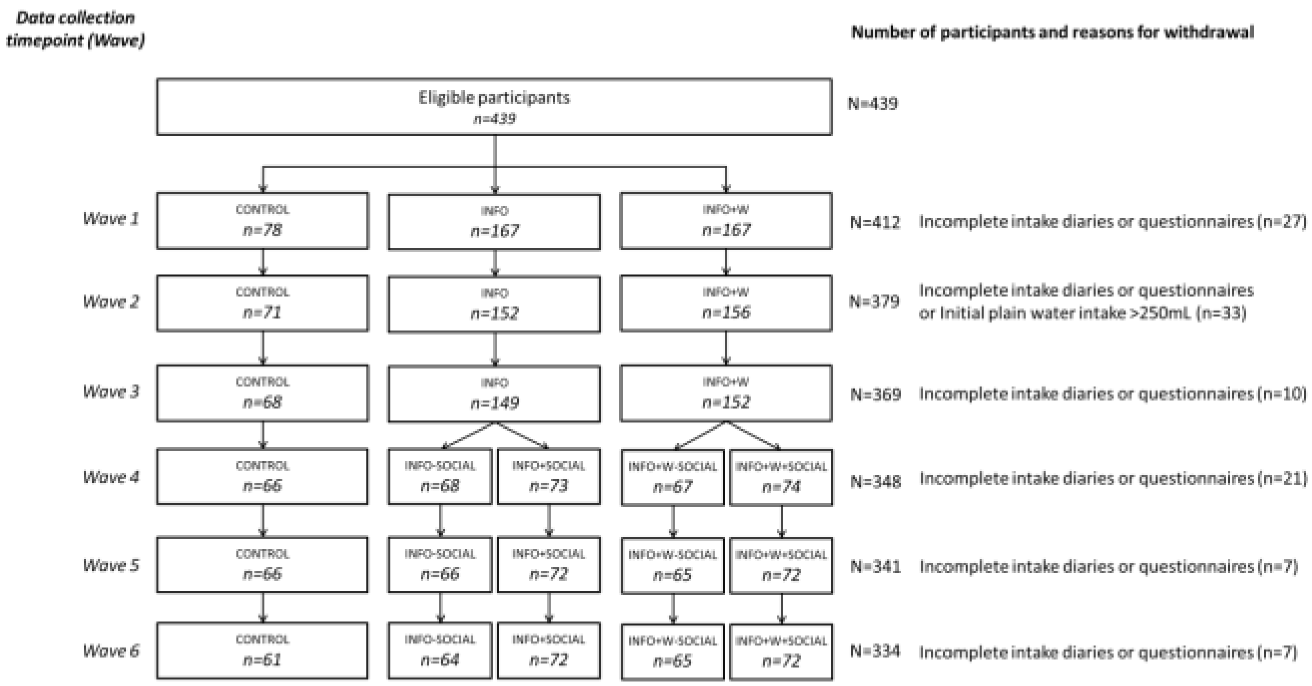

Figure 2. Sample Flow Chart

CONTROL *(Control)*: No experimental intervention; INFO (*Information):* Carers attending 6 online sessions; INFO+W *(Information + Water Affordance)*: Carers attending 6 online sessions and receiving water at home for the children; +SOCIAL *(Social Regulation):* Carers invited to join a community online discussion forum for 3 weeks; -SOCIAL: Carers receiving no additional input

Baseline plain water intake

The quantities of plain water consumed by children in the different interventions at the six waves are shown in Table 2. Relative changes in plain water intake from baseline for each group at each wave (recoded as baseline = 100% for each group) are shown in Figure 3. At baseline, overall mean plain water consumption was low, at 43.5 mL per day. There were no significant differences between groups at baseline.

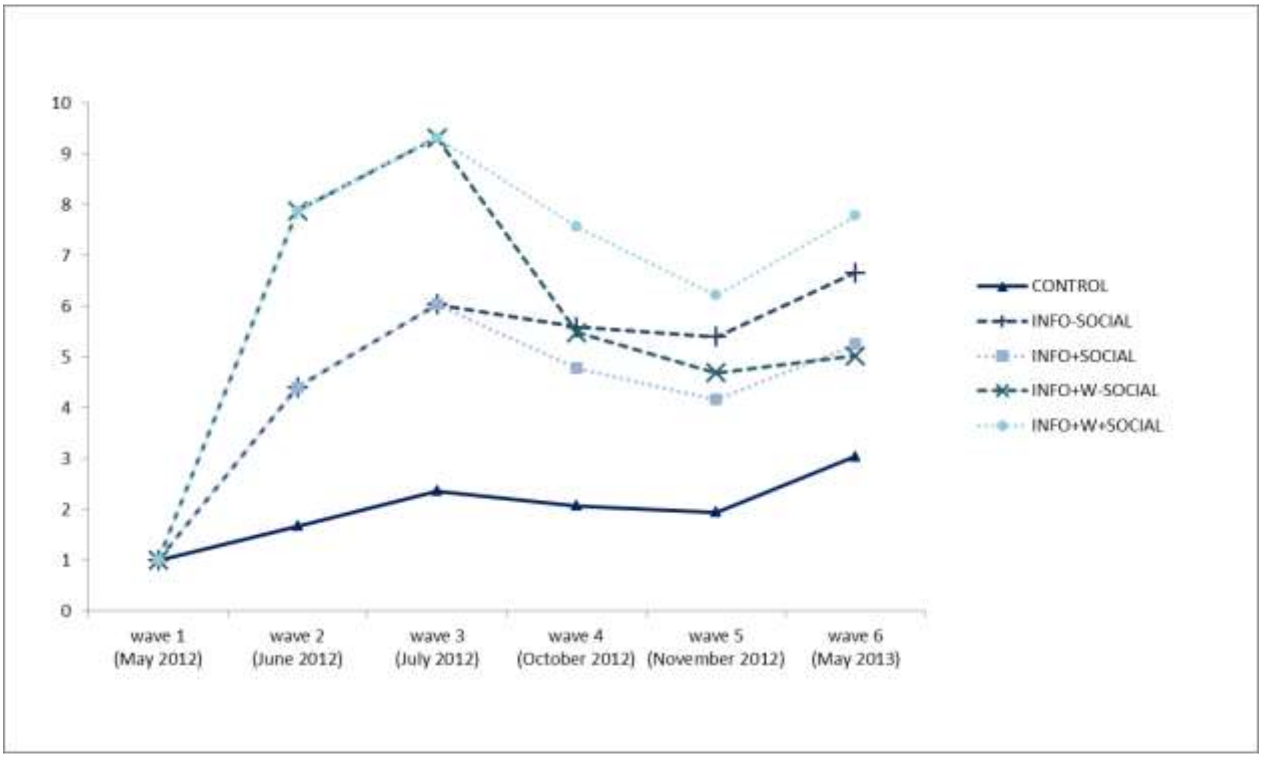

Figure 3. Relative change in water intake from baseline in all groups across all waves
CONTROL *(Control)*: No experimental intervention; INFO (*Information):* Carers attending 6 online sessions; INFO+W *(Information + Water Affordance)*: Carers attending 6 online sessions and receiving water at home for the children; +SOCIAL *(Social Regulation):* Carers invited to join a community online discussion forum for 3 weeks; -SOCIAL: Carers receiving no additional input

Table 2. Mean plain water intake (in mL) at each wave

	Wave					
Group	1 (May 2012)	2 (June 2012)	3 (July 2012)	4 (October 2012)	5 (November 2012)	6 (May 2013)
control	53.7 (83.4)	91.2 (99.3)	127.6 (147.5)	110.7 (133.2)	107.8 (125.3)	171.4 (156.5)
Info-social	44.0 (67.3)	186.0 (177.9)	244.6 (237.7)	217.9 (322.4)	209.1 (326.4)	265.9 (315.0)

Info+social	45.9 (67.0)	192.9 (209.5)	268.0 (274.6)	222.3 (268.8)	193.3 (258.3)	244.3 (275.5)
Info+w-social	39.6 (57.4)	256.7 (198.2)	293.0 (241.4)	215.1 (205.2)	184.4 (184.2)	197.5 (195.8)
Info+w+social	38.1 (79.4)	291.2 (197.0)	343.2 (238.4)	247.2 (210.4)	203.3 (177.4)	254.4 (219.5)

Water intake data presented as mean (standard error) in mL

Short- and Medium-Term Effects of the interventions on Plain Water Intake

Effect of Information and Water Affordance

At wave 2, analysis by ANOVA showed a significant overall difference in plain water intake between the 3 interventions (INFO, INFO+W, CONTROL) (F(2, 359) = 24.597), p < .0001; η^2_p =0.121) (Table 3). A η^2_p of 0.121 is considered a small/medium over-all effect size. Specific comparisons by Fisher's protected LSD (critical value of t = 1.962, 95% CI) revealed significant differences between CONTROL and both INFO and INFO+W groups, and also INFO and INFO+W (Table 3): Cohen's d shows large effect sizes for the difference between CONTROL and INFO+W (d = 1.07), and medium effect sizes for the difference between CONTROL and INFO (d = .58), and between INFO and INFO+W (d = .44). The following pattern of short-term impact emerges: *Information + Water Affordance > Information > Control*; this was replicated in the medium-term (wave 3, Table 3).

Table 3. Comparisons between Plain Water Intake of Different Groups at wave 2 and 3 (ANOVA)

	Wave 2 (June 2012)			Wave 3 (July 2012)		
Comparison	Mean Difference (SE)	p	Cohen's d	Mean Difference (SE)	p	Cohen's d
control vs Info	98.3 (26.9)	0001	.58	83.3 (23.7)	0001	.57
control vs info+w	183.9 (26.8)	0001	1.07	163.8 (26.9)	0001	.89
info vs info+w	85.6 (21.3)	0001	.44	65.6 (23.7)	0001	.26

Fisher's Protected LSD; critical value of t = 1.962. SE: standard error

Effects of *Social Regulation* on Plain Water Intake

At wave 4, analysis by ANOVA showed a significant overall difference between interventions , F(4, 340) = 3.308, p = .011; η^2_p =0.038), though only a small effect size (Table 4). Comparisons by Fisher's protected LSD (critical value of t = 1.962, 95% CI) revealed significant differences between CONTROL and each of the four intervention groups at wave 4 (INFO-SOCIAL Cohen's d = .43; INFO+W-SOCIAL d = .57; INFO+SOCIAL d = .49; INFO+W+SOCIAL d = .74) (Table 4).

All effect sizes were medium, except the difference between INFO+W+SOCIAL and CONTROL, which was medium-large. This suggests the following pattern of impact: *Information + Water Affordance + Social Regulation > Information + Water Availability > Information + Social Regulation > Information > Control*, substantially echoing that of waves 2 and 3. This was replicated in the medium-term at wave 5 (Table 4).

Table 4. Comparisons between Plain Water Intake of Different Groups at wave 4, 5, and 6 (ANOVA)

	Wave 4 (October 2012)			Wave 5 (November 2012)			Wave 6 (May 2013)		
Comparison	Mean difference (SE)		Cohen's d	Mean difference (SE)		Cohen's d	Mean difference (SE)		Cohen's d
control vs Info-social	107.2 (41.5)	010	. 43	8 2.1 (11.9)	0001	. 43	94.4 (43.0)	029	. 38
control vs info+w-social	104.4 (41.6)	013	. 57	9 7.5 (11.7)	0001	. 47	NS		
control vs Info+social	111.6 (40.6)	006	. 49	8 3.1 (11.7)	0001	. 41	NS		
control vs info+w+social	136.5 (40.6)	001	. 74	129.3 (11.7)	0001	. 60	83.0 (41.8)	048	43

Fisher's Protected LSD; critical value of *t* = 1.962. SE: standard error, NS: Non-significant

Long-Term Effects of the interventions on Plain Water Intake

Increase in Plain Water Intake Over the Year Within Groups

Overall analysis by within-groups MANOVA showed a substantial and significant increase in plain water intake over the year in all interventions (Table 5) :Wilks' Lamda = .492, F (5, 329) = 67.845, $p < 0.0001$, $\eta^2_p = 0.508$); by convention, a η^2_p value of over 0.26 is considered a large effect (Cohen, 1988; Wolf, 1986); this is therefore a very large effect. Bonferoni pairwise comparisons saw significant differences between baseline and final measurements for all interventions and the CONTROL ($p < 0.0001$). Mean plain water intake increased by between 5.0 times and 7.8 times across the intervention groups and by 3.0 times for the CONTROL over the year; corresponding to an average absolute increase in consumption of between 158 and 216 mL in the intervention groups and 118 mL in the CONTROL. The INFO+W+SOCIAL condition increased plain water intake the most between baseline and wave 6 - by 7.8 times (216 mL).

Table 5. Changes in plain water intake within groups from waves 1 to 6 (MANOVA)

	Mean absolute change (mL) (W6-W1)	Mean relative change (%) (W6-W1)	Wilks' λ	F (df)	p	η^2_p
control	117.7	+304	678	5.308 (5, 56)	0001	322
Info-social	221.9	+666	440	15.044 (5, 59)	0001	560
Info+social	198.4	+525	527	12.048 (5, 67)	0001	473
Info+w-social	157.9	+503	378	12.048 (5, 60)	0001	622
Info+w+social	216.3	+778	288	33.131 (5, 67)	0001	712

Bonferroni post-hoc test

Comparison of the Increase in Plain Water Intake Over a Year Between Groups

At wave 6 (May 2013), ANOVA showed no over-all significant difference between interventions and the CONTROL $F(4, 334) = 1.806$, $p = .127$), though there were significant differences for two specific comparisons: INFO-SOCIAL (p=0.029) and INFO+W+SOCIAL (p=0.048) were higher than CONTROL (Fisher's LSD; critical value of $t = 1.962$, 95% CI) (Table 4). Both effect sizes were medium (CONTROL versus INFO $d = .38$, CONTROL versus INFO+W+SOCIAL $d = .43$). The absence of many significant differences between intervention groups and control appears to be due to a significant increase in water consumption in the control group from wave 5 and 6 (from 109.7 mL to 171.4 mL of water per day); while in the other groups the increases are less impressive: see Table 1 and Figure 3).

Longitudinal Trends in Plain Water Intake

Turning to the longitudinal patterns, we conducted separate MANOVAS and ANOVA trend tests for each intervention. For all intervention groups, there were significant linear, quadratic and cubic trends (Supplementary table S2); for the CONTROL, there were significant linear and cubic trends but no significant quadratic trend (all significant F values at $p < .0001$). Given that nearly all trends were significant, we comment on the pattern formed by their effect sizes.

All groups showed a significant linear trend of increased plain water consumption over the year, with the largest effect sizes for the CONTROL and for INFO+W+SOCIAL. All intervention groups, unlike the CONTROL, also showed a significant quadratic trend: consumption sharply increased in the short term (wave 2 and 3) as a result of the interventions, before declining by November. INFO+W-SOCIAL and INFO+W+SOCIAL showed a far larger effect than INFO-SOCIAL and INFO+SOCIAL – *the impact of water availability on habits had a combined effect size almost twice that of* *information*. All groups, including CONTROL, also showed a significant cubic trend: consumption recovered again by wave 6 (May 2013) after declining at wave 5 (November 2012). The smallest effect was for the CONTROL, and the largest for INFO+W+SOCIAL, followed by INFO+W-SOCIAL – the relative recovery in consumption was greater for habits created by water availability than for those created by education. Moreover, the impact of social regulation on water availability (INFO+W+SOCIAL) resulted in a cubic trend of almost twice the effect size as the impact of social regulation on information (INFO+SOCIAL). *In summary, the intervention groups in general added to the underlying trends shown by the control (adding the quadratic trend) and amplified it in different ways (the cubic trend).* Moreover, the INFO-SOCIAL and INFO+SOCIAL groups revealed flatter quadratic and cubic trends (smaller effect sizes) than the INFO+W-SOCIAL and INFO+W+SOCIAL groups – the habits created by education were less prone to change (i.e., increasing or decreasing) once established than the habits created by water availability.

Intake of Sugar-Sweetened Beverages, Milk, and Other Fluids, and Total Fluid Intake

There was no significant change in TFI across all waves in each group (Table 6). The results of a MANOVA comparing the difference in mean consumption of SSBs between baseline and Wave 6, across interventions, are shown in Table 7. All interventions saw a significant decrease in SSB consumption over the time period of the study, the smallest being a mean reduction of 79.8 mL (-15%) for the INFO+SOCIAL group, and the largest a mean reduction of 171.7 mL (-27%) for the INFO+W+SOCIAL group . SSB consumption also decreased in the CONTROL (by 85mL, -16%) . No significant changes in milk intake, or other fluid intake were observed in this study (data not shown). *In short, the increased plain water consumption mainly comes from a substitution of water for SSB in all groups.*

Table 6. Mean Consumption of All Fluids by Group and Wave (mL)

	Wave 1 May 2012	Wave 2 June	Wave 3 July	Wave 4 October	Wave 5 November	Wave 6 May 2013
control	1206.0	1181.8	1250.1	1114.7	1108.3	1150.5
Info-social	1329.9	1332.4	1363.5	12881.1	1309.4	1358.5
Info+social	1191.0	1242.1	1349.2	1210.6	1174.9	1227.5
Info+w-social	1196.5	1182.5	1225.4	1171.3	1155.2	1200.2
Info+w+social	1324.2	1286.3	1358.3	12441.1	1218.9	1279.3

Table 7. Changes in Sugar Sweetened Beverage Intake Within Groups between wave 1 and wave 6 (MANOVA)

	Mean absolute difference (mL) (W6 -W1)	Mean relative difference (%)	SD	Wilks' λ	F (df)	p	η^2_p
control	- 85.96	-16	238.46	.568	8.521 (5, 56)	<.0001	432
Info-social	- 108.42	-17	295.44	.702	5.098 (5, 60)	<.001	298
Info+social	- 79.79	-15	263.51	.641	7.512 (5, 67)	<.0001	359
Info+w-social	- 110.49	-19	354.04	.396	7.871 (5, 60)	<.0001	396
Info+w+social	- 171.66	-27	325.00	.451	16.299 (5, 67)	<.0001	549

Bonferroni post-hoc test

Discussion

The aim of this longitudinal year-long controlled field experiment was to assess the effect of different kinds of interventions on children's plain water consumption habits: providing information, manipulating the physical context (water availability), and social regulation (influence of the community). Our goal was for children with unhealthy drinking habits to develop a stronger habit to drink plain water, measured by a greater quantity consumed per day. Our hypothesis was, according to Installation Theory, that an intervention combining education, affordances and social regulation would be most successful in changing habits. Our results show that plain water intake massively increased after one year in all groups (from 3.0 times for CONTROL to 7.8 for INFO+W+SOCIAL). In the short-and medium-term (wave 2 to wave 5), all interventions led to significantly higher increases in plain water intake than the CONTROL. After one year, however, the difference remained marginally significant between the INFO-SOCIAL and the INFO+W+SOCIAL groups and the CONTROL only . Although the study did not intend to modify SSB intake directly, the intake of SSB decreased in all groups (between 16-27%). Changes in SSB intake are striking in part because they arose spontaneously as a byproduct of developing habits to drink more plain water, including in the CONTROL group. Our methods inspired by Installation Theory were successful in increasing plain water intake . The condition that created the largest effect sizes in increasing plain water consumption and in reducing SSB consumption, combined all 3 levels of intervention: information, water affordance, and social regulation, confirming our hypothesis. This confirms the results of past research on changing habits by a combination of methods, and more interestingly shows that their effects interact rather than being merely additive. Habits may profitably be seen in this broader way, reflecting a societal psychology approach (Howarth, et al., 2013), rather than taking one facet to be key. One open question was the relative size of effects of the various layers of behavior determination. It appears that material affordances (here, water affordance) have the strongest impact; but this impact is (as one could expect) maximal only when the affordances are present (see discussion below).

The two underlying temporal patterns for *all* groups including the Control – general increased water consumption over the year and cubic variation within the year – require explanation. The cubic evolution combines a sinusoidal trend (a strong increase in consumption followed by a relative decrease, which was then followed by a further increase) and a linear increase (see Figure 3). The sinusoidal trend may be attributed to seasonality and/or the nature of habit formation: on the one hand plain water conumption water might be expected to increase in warmer weather , and decrease in colder weather . On the other hand, habit formation has itself been found to be asymptotic over time (Lally, Van Jaarsveld, Potts, & Wardle, 2010): performance reaches a peak before dipping and then stabilizing. The data do not allow us to disentangle these possibilities, which may both be at play. The linear trend may likely be explained by different factors, none of which could be controlled for; one is a Hawthorne Effect: the mere fact of being observed (Mayo, 1949); since control participants must measure their water intake, this inevitably makes them more aware, which might distort their responses; a second is social desirability,awareness of the positive value attached to drinking more water (Sanzone, et al., 2013), which could be made more salient by the fact of completing the liquid intake diaries; a third is natural child maturation: children might drink more water as they get older (IPSOS-MORI /DEFRA, 2012); finally, there might be a learning effect on completing online diaries, and possibly other uncontrolled factors such as national advertising campaigns. The current protocol does not allow for untangling these various effects, but a finding of this research is that they are substantial and should be considered in further studies. At least they impact equally all the groups. Such complexities seem a natural consequence of a longitudinal study in real world field settings, compared to a restricted time laboratory study. The linear trend confirms the need for a control group in researching real-world habits, and the cubic trend confirms the need to track habits over a time period that allows for real world factors to increase or inhibit their expression.

Other questions concern the long-term impacts of different interventions. Perhaps surprising were the results for INFO+W-SOCIAL (the lowest long-term impact) and INFO+W+SOCIAL (the highest). However, these results again reflect some important aspects of habits. As Verplanken & Wood (2006) found, habits can be 'vulnerable' if they depend on specific cues which are removed. INFO+W has the strongest effect of all while the affordance is in place - see Table 2: at wave 2, INFO+W increased from Baseline 3.8 times more than CONTROL (6.5 times vs 1.70 times), while INFO increased 2.5 times more than CONTROL (4.2 times vs 1.7 times); but this markedly decreased when the water bottles were no longer provided and no direct means for the child to generalize was available (e.g., to another easily available water source, such as a reachable tap). Adding in social regulation by joining the forum (supporting generalizing the behavior via practical social support and tips) then increased performance dramatically, by ensuring that the affordances were culturally salient and supported: *Information* + *Water Affordance* + *Social Regulation* > *Information* + *Water Affordance* alone. Hence, even if habit vulnerability leads to medium term decline in performance, it may later be improved by supportive group norms.

By contrast with *Information* + *Water Affordance*, Information's strong early performance was later *dampened* by adding the forum. A possible reason lies in findings that exposure to cues for a habit can sometimes reduce performance rather than increase it (Glaser & Banaji, 1999). For example when a habit that was created using implicit methods is followed with an explicit cue (as in Information + Social Regulation), a reverse priming or contrast effect is produced, in which habit performance is decreased (Laran, Dalton, & Andrade, 2011). Finally, plain water intake for INFO-SOCIAL also increased significantly at wave 5 and 6, and was significantly higher than CONTROL at wave 6. While INFO-SOCIAL'S increased intake after wave 5 is exactly parallel to the increase of the CONTROL group and therefore quite understandable (effect of seasonality etc.), it is still surprising that at wave 6, INFO-SOCIAL's intake is higher than that of INFO+SOCIAL. It may be that the content posted by parents in the forum was at odds with the 'official' information provided initially. Or, parallel to the reverse priming possibility above, the two may have had contradictory normative effects. It is also possible that the use of the online forum was not homogeneous or continuous within the +SOCIAL conditions. This suggests a need for research on the most successful interactions between techniques, since our results suggest that the 'nudging' of habits across different techniques may not be summative.

A range of methodological issues should be noted. Since it was not possible for the children to record their own fluid intake, parents were asked to provide the information. Although this may have biased the recording process , there is currently no validated method to measure fluid intake in young children. The possibility of over- or under-estimation was limited in two ways: by providing a convenient online record with images of a range of standard containers and volume equivalent indicators to help estimate quantities, and by recording intake over 7 consecutive days per wave to limit the effect of day-to-day variability. However, it is acknowledged that providing information to parents about the importance of water intake prior to the completion of fluid intake diaries may have added to social desirability effects (see above) . Future studies might also collect urinary biomarkers of hydration to further confirm the reliability of TFI data, since values of 24-h urine osmolality and urine specific gravity correlate strongly with daily TFI (Perrier, et al., 2013).

A specific population of children with low plain water and high SSB intake was recruited for this study; this may limit the extrapolation of the results to other populations, especially in countries with different pattern of fluid intake (Guelinckx, Iglesia, et al., 2015; Iglesia, et al., 2015). However, this sample is likely to be representative of a large part of children in Poland as mentioned in the method section above (sample description). Additionally, most interventions that aim to increase children's plain water intake indirectly target low water drinkers, who are therefore more likely to behave in a similar way as children from our sample. In our over-all sample, baseline plain water intake was very low, 43.5 mL per day. It might thus be suggested that the increase in water intake we observed may exceed that of interventions targeting a wider population of children. On the contrary, in other studies a similar increase in plain water intake was observed, suggesting that baseline plain water intake may not necessarily affect the effectiveness of interventions (European Commission, 2016). Since fluid intake behavior is influenced by cultural and geographical factors, future research should assess the effect of multi-level interventions in other countries and populations, especially in different age groups, because TFI and the contribution of plain water intake changes with age (Drewnowski, et al., 2013; Garriguet, 2008),

Conclusion

A year-long field experiment with 334 households assessed the capacity of several "installations" to increase plain water intake in children with unhealthy drinking habits in the short and long term. It addressed Installation Theory's three layers of determinants of behavior (embodied interpretation systems, affordances of the environment, social regulation) by providing information, water availability, and social regulation. After one year, all interventions significantly increased plain water consumption compared with baseline intake: from 3.0 times for the CONTROL to 7.8 times for the INFO+W+SOCIAL group. The increase in plain water intake was significantly higher than that of the CONTROL for all interventions in the short term, and combining them produces a stronger effect on plain water intake, as predicted by Installation Theory. In the long term, the increase in plain water intake remained significant for INFO+W+SOCIAL (the strongest effect) and for INFO-SOCIAL, while the increase in INFO+SOCIAL and in INFO+W-SOCIAL fell below significant difference, probably because discrepant sources of information might cancel each other out and so reduce influence, and the withdrawal of affordances is not compensated by social regulation . This suggests implications for other policies concerned with changing health-related behaviours. Changing health-related habits is complex, but is made more tractable by understanding the impacts of the different levers of behavioural change and the way they interact.

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Declaration of interest

IG, and JHB are full-time employees of Danone Research. SBM is a full-time employee of Nutricia Research.

Reference List

Aarts, H., Gollwitzer, P. M., & Hassin, R. R. (2004). Goal contagion: perceiving is for pursuing. *J Pers Soc Psychol, 87*, 23-37.

Anderson, L. M., Symoniak, E. D., & Epstein, L. H. (2014). A randomized pilot trial of an integrated school-worksite weight control program. *Health Psychol, 33*, 1421-1425.

Avery, A., Bostock, L., & McCullough, F. (2015). A systematic review investigating interventions that can help reduce consumption of sugar-sweetened beverages in children leading to changes in body fatness. *J Hum Nutr Diet, 28 Suppl 1*, 52-64.

Beech, B. M., Klesges, R. C., Kumanyika, S. K., Murray, D. M., Klesges, L., McClanahan, B., Slawson, D., Nunnally, C., Rochon, J., McLain-Allen, B., & Pree-Cary, J. (2003). Child- and parent-targeted interventions: the Memphis GEMS pilot study. *Ethn Dis, 13*, S40-53.

Connell, L. E., & Francis, L. A. (2014). Positive parenting mitigates the effects of poor self-regulation on body mass index trajectories from ages 4-15 years. *Health Psychol, 33*, 757-764.

Dik, G., & Aarts, H. (2007). Behavioral cues to others' motivation and goal pursuits: The perception of effort facilitates goal inference and contagion. *Journal of Experimental Social Psychology, 43*, 727-737.

Drewnowski, A., Rehm, C. D., & Constant, F. (2013). Water and beverage consumption among adults in the United States: cross-sectional study using data from NHANES 2005-2010. *BMC Public Health, 13*, 1068.

EFSA Panel on Dietetic Products Nutrition and Allergies (NDA). (2010). Scientific Opinion on Dietary reference values for water. *EFSA Journal, 8*, 1459-1507.

European Commission, J. R. C. (2016). How to promote water intake in schools: A toolkit. In *JRC Science for Policy Report*.

Garriguet, D. (2008). Beverage consumption of children and teens. *Health Rep, 19*, 17-22.

Glaser, J., & Banaji, M. R. (1999). When fair is foul and foul is fair: reverse priming in automatic evaluation. *J Pers Soc Psychol, 77*, 669-687.

Gleibs, I. H., Haslam, C., Haslam, S. A., & Jones, J. M. (2011). Water clubs in residential care: is it the water or the club that enhances health and well-being? *Psychol Health, 26*, 1361-1377.

Guelinckx, I., Iglesia-Altaba, I., Bottin, J. H., De Miguel-Etayo, P., Gonzalez-Gil, E. M., Salas-Salvado, J., Kavouras, S. A., Gandy, J., Martinez, H., Bardosono, S., Abdollahi, M., Nasseri, E., Jarosz, A., Ma, G., Carmuega, E., Thiebaut, I., & Moreno, L. A. (2015). Intake of water and beverages of children and adolescents in 13 countries. *European Journal of Nutrition, 54 Suppl*, S69-S79.

Guelinckx, I., Iglesia, I., Bottin, J. H., De Miguel-Etayo, P., Gonzalez-Gil, E. M., Salas-Salvado, J., Kavouras, S. A., Gandy, J., Martinez, H., Bardosono, S., Abdollahi, M., Nasseri, E., Jarosz, A., Ma, G., Carmuega, E., Thiebaut, I., & Moreno, L. A. (2015). Intake of water and beverages of children and adolescents in 13 countries. *Eur.J Nutr., 54 Suppl 2*, 69-79.

Howarth, C., Campbell, C., Cornish, F., Franks, B., Garcia-Lorenzo, L., Gillespie, A., Gleibs, I., Gonvales-Portelinha, I., Jovchelovitch, S., & Lahlou, S. (2013). Insights from Societal Psychology: The contextual politics of change. *Journal of Social and Political Psychology, 1*, 364-384.

Huang, T. T., Drewnosksi, A., Kumanyika, S., & Glass, T. A. (2009). A systems-oriented multilevel framework for addressing obesity in the 21st century. *Prev Chronic Dis, 6*, A82.

Iglesia, I., Guelinckx, I., De Miguel-Etayo, P. M., Gonzalez-Gil, E. M., Salas-Salvado, J., Kavouras, S. A., Gandy, J., Martinez, H., Bardosono, S., Abdollahi, M., Nasseri, E., Jarosz, A., Ma, G., Carmuega, E., Thiebaut, I., & Moreno, L. A. (2015). Total fluid intake of children and adolescents: cross-sectional surveys in 13 countries worldwide. *Eur.J Nutr., 54 Suppl 2*, 57-67.

Institute of Medicine, & Food and Nutrition Board. (2004). *Dietary Reference Intakes for water, potassium, sodium, chloride and sulfate*. Washington DC: National Academies Press.

James, J., Thomas, P., Cavan, D., & Kerr, D. (2004). Preventing childhood obesity by reducing consumption of carbonated drinks: cluster randomised controlled trial. *Bmj, 328*, 1237.

Janicke, D. M. (2013). Treatment of pediatric obesity using a parent-only approach: a case example. *Health Psychology, 32*, 345.

Kaufman-Shriqui, V., Fraser, D., Friger, M., Geva, D., Bilenko, N., Vardi, H., Elhadad, N., Mor, K., Feine, Z., & Shahar, D. R. (2016). Effect of a School-Based Intervention on Nutritional Knowledge and Habits of Low-Socioeconomic School Children in Israel: A Cluster-Randomized Controlled Trial. *Nutrients, 8*, 234.

Kulaga, Z., Grajda, A., Gurzkowska, B., Gozdz, M., Wojtylo, M., Swiader, A., Rozdzynska-Swiatkowska, A., & Litwin, M. (2013). Polish 2012 growth references for preschool children. *Eur J Pediatr, 172*, 753-761.

Lahlou, S., Boesen-Mariani, S., Franks, B., & Guelinckx, I. (2015). Increasing Water Intake of Children and Parents in the Family Setting: A Randomized, Controlled Intervention Using Installation Theory. *Ann.Nutr.Metab., 66 Suppl 3*, 26-30.

Lally, P., Van Jaarsveld, C. H., Potts, H. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European journal of social psychology, 40*, 998-1009.

Laran, J., Dalton, A. N., & Andrade, E. B. (2011). The curious case of behavioral backlash: Why brands produce priming effects and slogans produce reverse priming effects. *Journal of Consumer Research, 37*, 999-1014.

Lewin, K. (1943). Forces behind food habits and methods of change. *Bulletin of the national Research Council, 108*, 35-65.

Loersch, C., Aarts, H., Payne, B. K., & Jefferis, V. E. (2008). The influence of social groups on goal contagion. *Journal of Experimental Social Psychology, 44*, 1555-1558.

Mayo, E. (1949). Hawthorne and the western electric company. In.

Muckelbauer, R., Libuda, L., Clausen, K., Toschke, A. M., Reinehr, T., & Kersting, M. (2009). Promotion and provision of drinking water in schools for overweight prevention: randomized, controlled cluster trial. *Pediatrics, 123*, e661-667.

Natale, R. A., Lopez-Mitnik, G., Uhlhorn, S. B., Asfour, L., & Messiah, S. E. (2014). Effect of a child care center-based obesity prevention program on body mass index and nutrition practices among preschool-aged children. *Health Promot Pract, 15*, 695-705.

Ozen, A. E., Bibiloni Mdel, M., Pons, A., & Tur, J. A. (2015). Fluid intake from beverages across age groups: a systematic review. *J Hum Nutr Diet, 28*, 417-442.

Perrier, E., Rondeau, P., Poupin, M., Le, B. L., Armstrong, L. E., Lang, F., Stookey, J., Tack, I., Vergne, S., & Klein, A. (2013). Relation between urinary hydration biomarkers and total fluid intake in healthy adults. *Eur J Clin Nutr., 67*, 939-943.

Sanzone, L. A., Lee, J. Y., Divaris, K., DeWalt, D. A., Baker, A. D., & Vann Jr, W. F. (2013). A cross sectional study examining social desirability bias in caregiver reporting of children's oral health behaviors. *BMC Oral Health, 13*, 1.

Schwartz, A. E., Leardo, M., Aneja, S., & Elbel, B. (2016). Effect of a School-Based Water Intervention on Child Body Mass Index and Obesity. *JAMA pediatrics, 170*, 220-226.

Sichieri, R., Paula Trotte, A., de Souza, R. A., & Veiga, G. V. (2009). School randomised trial on prevention of excessive weight gain by discouraging students from drinking sodas. *Public Health Nutr, 12*, 197-202.

Story, M., Hannan, P. J., Fulkerson, J. A., Rock, B. H., Smyth, M., Arcan, C., & Himes, J. H. (2012). Bright Start: Description and main outcomes from a group-randomized obesity prevention trial in American Indian children. *Obesity (Silver Spring), 20*, 2241-2249.

Wang, Y. C., Ludwig, D. S., Sonneville, K., & Gortmaker, S. L. (2009). Impact of change in sweetened caloric beverage consumption on energy intake among children and adolescents. *Arch Pediatr Adolesc Med, 163*, 336-343.

Online supporting information

Supplementary Table S1. Classification of the fluid types

Classification of fluids	Detailed Fluid types
Plain Water	Bottled still water, unflavored carbonated water, tap/filtered/boiled water
Milk and derivatives	Low fat and full fat milk, fermented milk, ready-to-drink milk, flavored milk, yogurt milk, powder milk, powder/syrup flavored milk, fruit shake with milk, cocoa compound with milk
Sugar Sweetened Beverage (SSB)	• Carbonated soft drinks: regular and diet/light/zero cola carbonated drinks, regular and diet/light/zero flavored carbonated drinks, tonic, soda, fruit shake with water powder, ready to drink tea, ready to drink ice tea, vitamin/ functional drinks (fiber, vitamin and cooling drinks such as C1000 Vitamin Lemon), • Fruit non-carbonated drinks • Flavored sparkling water, Flavored packaged water, flavored waters made with powder or concentrate/syrup, cocoa compound with water • Kompot (traditional homemade fruit brew) • Packages fruits & vegetables juices (packages juices (fruits or vegetables), packaged orangeade, packages nectars, smoothies), natural fruits & vegetables juices (natural fruit/vegetable juices, restaurant lemonade/orangeade) • Hot beverages (containing on average 2 spoons of sugar): homemade hot/cold tea (from tea bags), Infusions (herbal tea) , coffee
Alcoholic beverages	Beer, malt Beer, beer mix drinks, Wine, Champagne, Aperitifs and digestives, packages/canned alcoholic beverages,
Other beverages	• Beverages identified by participant as “other than listed above” • packaged soy drinks, energy and sports drinks

Supplementary Table S2. Trend analyses of plain water intake within groups throughout the study (ANOVA)

	Trend	F(df)	P	η^2_p
control	Linear	21.694 (1, 60)	.000	.266
	Quadratic	.356	.553	.006
	Cubic	9.633	.003	.138
Info-social	Linear	17.434 (1, 63)	.000	.217
	Quadratic	18.662	.000	.229
	Cubic	28.227	.000	.309
Info+social	Linear	18.217 (1, 71)	.000	.204
	Quadratic	26.751	.000	.274
	Cubic	27.583	.000	.280
Info+w-social	Linear	9.844 (1, 64)	.000	.133
	Quadratic	62.327	.000	.493
	Cubic	44.042	.000	.408
Info+w+social	Linear	23.350 (1, 64)	.000	.247
	Quadratic	103.414	.000	.593
	Cubic	75.752	.000	.516