



# 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 daily water consumption by 3.0–7.8 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.

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## 1. Introduction

Young children in many countries currently drink less water

**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.

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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 4–9 years obtained less than an adequate intake of water from fluids (Guelinckx, et al., 2015; Iglesia

et al., 2015). In a study of US children aged 4–8 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, et al., 2015). In another review, the contribution of plain water to TFI in children ranged from only 21–58%, 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, Drewnowski, Kumanyika, & Glass, 2009). Installation Theory (Lahlou, 2017, in press) 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. 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, 2010), 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; Sichiari, 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; Sichiari 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, Sonnevile, & 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 (by providing information), affordances of the environment (here, by providing affordance for drinking plain water, in short "water affordance"), and social regulation (by providing 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.

## 2. Methods

### 2.1. 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 150 ml 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

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