Behaviour settings theory applied to domestic water use in Nigeria: a new conceptual tool for the study of routine behaviour

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Key words: behaviour settings, behaviour change, water use, formative research, routine, qualitative research

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Abstract

Many behaviours relevant to public health are part of everyday routines. However, few tools exist to study such behaviours. Here we re-introduce the behaviour setting, a theoretical concept developed in the 1950s, as an approach to the study of routine behaviour. The setting concept bridges theoretical and applied approaches in sociology, psychology and social practice; its components include *stage*, *infrastructure*, *props*, *roles*, *norms*, *competencies*, *objectives* and resultant routines. We apply settings theory to health-related water use behaviour in rural Nigeria. We captured the dimensions of water use behaviour settings in 23 households at varying distances from newly-introduced kiosks selling purified water. We found that that routines concerning drinking, laundering, dish washing and handwashing were stable in their settings, varying little between households or by type of water source. Hygiene routines were suboptimal but drinking water was carefully segregated. The findings imply that the majority of water use behaviour was governed, not by an immediate desire to maximise health, but by long-established routines embedded in the social, technical and physical environment. It appears that that water kiosks are making only marginal improvements to the quantity and quality of water being used in homes. Improving public health will require the disruption of settings, for example, through bringing water *infrastructure* directly to the home, through the sale of new *props* that facilitate hygienic routines, or in the disruption of gender *roles* via the promotion of new *norms*. Settings are an ecologically valid, meso-level theoretical approach that link social and techno-physical environmental factors to behaviour. They provide a comprehensive framework within which to judge avenues for changing routine behaviours. The behaviour settings tool we developed was easy to use, provided a systematic means of capturing the determinants of routine behaviour, and the findings offered insight into methods for disrupting it.

Key words: behaviour settings, behaviour change, water use, formative research, routine, qualitative research

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1. Introduction

Many of the behaviours that public health professionals seek to change form part of the routine of daily life. Dietary, hygiene, exercise, child care, medical compliance, and substance abuse practices, for example, are often repeatedly enacted at fixed times, using similar objects, and in the same locations. However, few intellectual or operational tools exist for the study of routine behaviour. In this paper we apply *behaviour settings theory* to the study of water use behaviour in relation to health in Nigeria. We describe a simple approach for capturing data on the dimensions of behaviour settings and demonstrate the utility of the settings concept in providing insights for behaviour change programming.

The need for better formative research tools

It is increasingly recognised that public health interventions should be designed on the basis of prior evidence and careful research into behaviour and its determinants in the context where it is taking place (Craig et al., 2008; De Silva et al., 2014). This is typically referred to as 'formative research' (FR)[(V. Curtis et al., 1997). However, the methods commonly used in FR may not be well suited to the understanding of daily routine behaviour. Talk-based methods such as in-depth interviewing, focus group discussions, and surveys can help to understand knowledge, beliefs, and attitudes. Routine behaviours, though, are generally not governed by knowledge and belief, but by subconscious drivers and by automatic and learnt responses to the immediate social or physical environment in which behaviour occurs (Aunger & Curtis, 2016; Ouellette & Wood, 1998; Wood & Runger, 2016). Hence, self-report can provide an inaccurate picture of the determinants of routine

behaviour. This is a major challenge for those seeking to employ systematic and theory-based approaches to the design of public health interventions.

What is behaviour settings theory?

Behaviour settings theory was first elaborated in the 1950s by the ecological psychologist Roger Barker (Barker, 1968). Barker and his team collected data on more than 100,000 episodes of behaviour over a whole year in the town of Oskaloosa, Kansas in a range of domestic, social and community events. Through this monumental effort to study human behaviour in its natural context, Barker and colleagues concluded that most behaviour was not a function of the individual, their emotions, motivations and life history. It was rather a function of their *behaviour setting*. A school, for example, was not just a physical place, but a context in which the physical layout and social forces shaped or 'coerced' the actions of the students in behaviour settings, such as assembly, music class and play-time. According to Barker: "All inhabitants of the tavern behaved tavern and all of the inhabitants of the drugstore behaved drugstore" (Barker, 1968). He suggested that settings include their own deviance correction mechanisms: "Bridge clubs turn away poker players, teachers shush loudmouths, and if that doesn't work, the principal expels them." Barker described how the *milieu*, the *props* being used, the *rules* being followed, and the *roles* being played, are *synomorphic* with behaviour -- meaning that they interact with behaviour in settings to form standing, predictable patterns which meet specific objectives. Wicker, one of Barker's students, formally defined behaviour settings as "small-scale social systems composed of people interacting with one another and with their physical surroundings to carry out.. …regularly occurring behavioral sequences." (Wicker, 1987).

Though settings theory did not survive the cognitive revolution of the sixties, it has some similarities with other, still influential, approaches in the behavioural sciences. Behaviour settings grew out of

Lewin's 'field theory', which had behaviour as a function of the interaction of an embodied mind with relevant aspects of the physical surroundings (Lewin, 1939). In sociology settings have some overlaps with Goffman's notion of frames, or schemata, which are culturally-shared mental models for understanding and organizing experience. (Goffman, 1974) In social psychology, interdependency theory aims to categorise how social agents interact in a range of defined and re-occurring situations (Harold H Kelley et al., 2003; H. H. Kelley & Thibaut, 1978). Settings' closest parallel is to be found in cultural sociology with the notion of a 'social practice'. (Nicolini, 2012) Shove and colleagues propose that social practices can be considered activities with three specific 'elements': *materials* (the tangible entities – technological and otherwise – which form part of the practice), *competencies* (the skills, knowledge and abilities required to enact the practice), and *meanings* (the shared understanding among practitioners of the reason why the practice exists). (Shove et al., 2012)

The heterogenous nature of the setting concept makes it unusual, but also unusually powerful, as it can link human and non-human factors together through regulatory forces such as normative rules and recognition that physical structures are often designed to facilitate particular kinds of behaviour (what Barker called *synomorphies*). Settings help to bridge the gap between approaches that see individuals as fully autonomous, independent agents and those that see individuals as passive participants in larger social structures. That is – behaviour settings theory posits that individuals have *constrained agency*. Further, unlike many of the approaches discussed above, settings are easy to operationalise by capturing their observable dimensions.

Returning to our own field of behaviour change practice, settings theory offers a theoretical link between a number of popular approaches such as 'Nudge theory' (Thaler & Sunstein, 2008) which targets automatic processes through making changes to the choice architecture, social norm change,

(Bicchieri et al., 2017) habit formation (Wood & Runger, 2016) and social ecology theory (Stokols, 1992), which is one of the few current approaches to make explicit reference to environmental contexts.

This ability to unify disciplines, concepts and to operationalise them is what makes behaviour settings theory ready for revival. We have taken Barker's original dimensions of a setting and combined them with later insights from community psychologists (Tharp & Gallimore, 1988) and social practice theoreticians (Shove et al., 2012), as well as from Goffman's Frame theory (Goffman, 1959). The components we now employ are *stage, infrastructure, props, roles, routines, competencies, norms,* and *objectives,* which we define in detail in the methods section. Figure 1 shows an example. On a *stage* (i.e., the bathroom, seen as the situational context or milieu within which the setting takes place) a girl uses durable technologies called *infrastructure* (taps, basin) and manipulated *props* (soap) to teach (*role*) a sibling *competency* in handwashing, which is supported by a *norm* (socially enforced preference) in her family and society. The inferred *objectives* of this behaviour setting are decontamination and social assimilation. The result is that the child carries out handwashing with soap as a regular *routine* (i.e., regularized sequence of behaviours, enacted in roughly the same order repeatedly, typically with little conscious attention; see Table 1 for setting component definitions).

Insert Figure 1 here. A behaviour setting and its components

Once the role of behaviour settings in shaping specific everyday behaviours is understood, *disrupting* settings provides an opportunity to instil new standing patterns or *routines*. An intervention to disrupt food preparation behaviour settings to improve infant food hygiene in rural Nepal provides an

example. We changed the *stage* by carrying out kitchen makeovers, the *props* by adding kitchen gadgets, the *norms* through having women pledge to employ five new food hygiene practices, and the *roles* by encouraging women to become hygiene champions. This led to major changes in food hygiene behaviours, with 43% of mothers performing the five targeted food hygiene behaviours in the intervention group versus 2% in the control group (Gautam et al., 2017). In Bangladesh we disrupted school toilet settings by painting bright coloured footprints between toilets and handwash facilities – providing a *stage*, *infrastructure*, and *props* that fostered new standing behaviour patterns – resulting in sustained improvements in handwashing behaviour five months after the intervention (Grover et al., 2018).

Water use behaviour in Nigeria

This study applies behaviour settings theory to the issue of domestic water use in Nigeria. Nigeria has some of the poorest water supply conditions in Africa. As of 2015, only 67% of the total and 54% of the rural population had access to a water supply that met the Sustainable Development Goal criteria for basic services ("Progress on sanitation and drinking water - 2015 update and MDG assessment," 2015). Even in the presence of an improved source, intermittent power supplies and lack of maintenance leads to supplies being irregular. This leaves populations dependent on open sources, private suppliers, public handpumps or rainwater. At least partly as a result, Nigeria is one of the largest contributors to the global burden of diarrhoeal diseases and has regular outbreaks of cholera (Troeger et al., 2017). A recent review suggests that upgrading water supplies could reduce diarrhoea risk by 23% (effect size 0.77 95% confidence interval (0.64–0.92)(Prüss-Ustün et al., 2014). The health benefits of an improved water source stem not only from improving the *quality* of the water, but also in improving the *quantity* of water available. Closer and more reliable water sources facilitate behaviours such as hand cleansing, personal hygiene and household cleaning, which decrease pathogen transmission (V. A. Curtis et al., 2000; Wolf et al., 2014). Secure access to

reliable water sources is also associated with reduced psychosocial stress, improved emotional well-being and quality of life (Bisung & Elliott, 2016, 2017; Stevenson et al., 2012; Wutich & Ragsdale, 2008).

As in many low-income settings where the public sector has not sufficiently met local water needs, small water enterprises play an important role in providing access to water resources (Huttinger et al., 2017). These range from informal, private vendors who sell water door-to-door to large commercial enterprises. The present study formed part of an assessment of opportunities to improve water access in low-income, rural areas around Abuja via water kiosks. Referred to locally as Water Centres, these are operated by a local NGO and are intended to be financially sustainable businesses. The Centres sell treated water that is pumped from deep bore wells by solar power. Water is then sold directly to individuals and also to resellers (known as *Me Ruwa*). Our objective in this formative research was to understand water use behaviour as it relates to public health.

2. Methods

Study site

Our study took place in the eight rural and peri-urban communities within a radius of 100 km of the city of Abuja in central Nigeria where Water Centres have been established. Formal water services are poor; reticulated water distribution systems are rare and public boreholes often dysfunctional. People therefore source water from a mix of private boreholes, public and private open wells and surface sources. In the rainy season (March-November) the main source of water for all households is catchment from roofs or private wells located on compounds. Households have fewer options in the dry season, when rainwater is unavailable and wells have run dry. Water resellers, known as *MeRuwa*, may supply clients from boreholes using push carts or household members may travel substantial distances to haul water from surface sources.

The household environment

Most households in the study area were located in walled compounds shared with related families (those of co-wives or other relatives). Separate, single-storey houses, usually made of concrete blocks with galvanised iron roofs, were situated around a communal earth-floored courtyard. Related families tended to share bathing, laundry and pit toilet areas, but not cooking facilities. Most water-related activity took place in the open, and bathrooms and toilets were rarely roofed. Some households had graduated from this traditional form of housing to individually-owned plots with improved facilities, such as interior bathrooms, kitchens and pit toilets with areas of concrete hard-standing in yards. A number of plots were given over to rental accommodation where multiple, single-room households negotiated limited shared space for cooking, laundry, bathing and toilets. The population of the study area depended economically mainly on farming and small businesses. They were ethnically and religiously mixed, and some women were under interdiction not to leave the compound, or only under close supervision.

Sampling

Behaviour settings data was collected from a total of 23 households in 8 communities. Households were chosen by selecting axes randomly starting from the Water Centres, and picking compounds at distances of approximately 1, 5 and 10 minutes' walk from the Centres. In compounds housing multiple families the most senior wife who was present was the respondent.

Data collection

In prior scoping work we identified seven categories of routine water use behaviour. These were: drinking, cooking, dishwashing, bathing, handwashing, laundry and 'other' (for example, watering plants, processing of agricultural products). Data was collected by direct observation and

photography of the physical components, through questioning about roles and skills, and by making short video clips of demonstrations of key behaviours, such as laundry or handwashing, when this was not observed during the visit. Often the researcher would ask for a drink of water or ask to use the toilet so as to participate in the setting. We developed a simple grid to capture the dimensions of water use behaviour for each of these behaviour settings. The rows concened the settings dimensions, and the columns the type of water use behaviour. Other data collected included distance from house to water centre, type of occupation (rented or owned), type of housing, religion and family size. Data were collected by two teams of enumerators, each composed of one international social scientist and one or two local social scientist/translators. Data were also collected concerning water choice factors and the operations of the Water Centres (reported elsewhere).

Settings dimensions, definitions and analysis

For each of the routine uses of water, we defined the dimensions of the behaviour setting and applied specific data collection methods as shown in table 1.

Data collection was straightforward: for example, the *stage* where laundry was observed to take place was often a corner of the yard. *Props* used in the water use setting were recorded by direct observation if the behaviour took place spontaneously during the visit, as it often did. If not, we asked for a demonstration. *Roles* played by different actors in the accomplishment of the setting were determined by direct observation, with additional information from interview, if needed. *Norms* were deduced by observing patterns of behaviour, for example the genuflexion that accompanied the offering of drinking water to an elder or visitor, and by interviewing about any social sanctions that would befall those who defaulted. *Competencies* with respect to water use was assessed by asking mothers how they had taught their children to accomplish these tasks. The *objectives* of the settings were deduced by observing what was accomplished during the setting. Two types of *routine* were captured, the sequence of activities involved in accomplishing the setting, by observation, and also

the placing of that the activity in the sequence of other daily tasks, by interviewing about the order in which household activities had taken place on the day before the visit.

At the end of each day the study teams reviewed all data captured, expanded their initial notes in the data collection grid, and discussed their observations and experiences. Common patterns emerged rapidly, and saturation, with little new emerging from the data, was achieved about half way through the data collection. Because water use behaviour settings were remarkably similar across all 24 households, our analysis presents the patterns of behaviour that appeared in the majority of cases and then discusses deviations from this pattern.

Ethics and consent

Ethical permission for the study was granted by LSHTM (No 11580). Study aims and procedures were explained to participants in local languages and written consent for all procedures was obtained. One interviewee opted out of photography and one household head declined to participate, so was replaced by the head of a neighbouring household.

3. Results

Fourteen of the 23 study households reported getting water from the Water Centre, of whom 6 used it exclusively. Those living nearer than 5 minutes walk from the centre were somewhat more likely to use it exclusively or partially (χ_2 =8.1394, p=0.017) than those living farther away.

Drinking water storage and use

The **typical** behaviour setting for drinking water was as follows: The *stage* for drinking water storage was the food storage and preparation area of the house, usually a separate room or corner of a living room. *Infrastructure* included large drums and large clay pots kept covered and designated for drinking water use only. *Props* included vessel stoppers, pot covers, and a tin or plastic mug kept on,

or near, the water vessel for the purpose of dipping. It was the *role* of the senior woman to manage household water, ensuring that the pot was kept filled. A junior female member of the household (younger co-wife, daughter in-law or older daughter) fetched the water to fill it when requested by the senior woman. The *routine* was for the person wishing to drink to serve themselves by dipping from the pot or pouring from the jerry can, as needed, and almost always after eating a meal. However, it was the *role* of the senior woman to ensure that senior men were served with water on request, and the *norm* was to offer this water with a genuflexion. Children became *competent* at serving themselves and others with water at an early age, and respondents reported that a child that spilled water or dropped or dirtied the drinking vessel would be corrected through scolding.

Variants of this setting were noted. The presence of visitors, such as ourselves engaged a supplementary set of *norms* such that senior household members would offer cooled sachet water to drink, often purchased from neighbours or local kiosks by a child sent out for that purpose. Some female respondents reported the occasional purchase of cooled sachet water to drink for themselves as a special treat on a hot day or after accomplishing a task. In some cases, senior household members would call a *MeRuwa* to bring supplies when drinking water ran low, and in the rainy season rainwater would be collected for drinking. In three cases, senior men reported that they had insisted on a *norm* that the family purchase water for drinking from a particular source, which was used only for drinking, because they believed that water to be reliably pure. In the rainy season water was collected from roofs into basins but rapidly decanted into drinking water vessels and then used as above.

The inferred *objective* of the drinking water behaviour setting was thus for the participants to be able to drink carefully segregated potable water on demand.

Dishwashing

Typically, the *stage* for washing used dishes, pans and utensils was a fixed area of the open courtyard with some *infrastructure* such as stones or broken concrete hard standing, to absorb the small amount of waste or spilt water. *Props* included an openwork basket to hold dirty dishes, a low stool for sitting on, a metal bowl or bucket holding water, a second bowl of water for rinsing, a small piece of sack as a scourer and a piece of locally made black soap or small sachet of detergent powder in a plastic soap dish. Few items of cutlery were employed. The typical r*outine* was for cooking and eating dishes to be collected into a basket after a meal and left outside until someone had time to do the washing up, usually twice a day. At that point water was collected in a bucket from a general storage vessel and soap brought from inside the house. Each dish was soaped and scoured thoroughly and then rinsed in two types of water, semi-dirty and then clean. Water was used and reused in minimal quantities for soaping and rinsing. Little water was spilled on the ground. *Roles* were again determined by age and gender, with the youngest available *competent* girl normally tasked with washing up. However, mothers explained that this *norm* has changed because children may now be busy with school and homework.

Variants: in one large family household a small boy and a small girl (aged around 5), were seen to individually wash up their own dishes after eating. In one household a senior male claimed to help his wife wash up, and in another a live-in aunt always did the dishes.

Objective: the dishwashing behaviour setting serves to maximise efficiency in making dishes shiny and visibly residue-free with as little consumption of water and cleansing agents as possible. Routines, props, and competencies aided in minimising water loss during the washing process.

Laundry

Typically, the *stage* for laundry was an open area of the compound, usually with some hard standing, such as a step or stones with an incline where water could drain or soak away. Water for laundry was usually stored in drums (*infrastructure*) and drawn as needed using buckets and plastic bowls as dippers (*props*). Other *props* were laundry bowls and packets of laundry detergent, purchased mostly in single dose sachets. The laundry *routine* was similar to the dishwashing routine, in that small amounts of water were used to dissolve the soap and apply it to the fabric, then physical effort was expended to rub away dirt, then the fabric was rinsed using the minimum amount of water. The way in which this was achieved followed a standard routine with a stereotypical action of making a lot of lather and then running fabric through the hands. Clothes were then hung over fences, bushes and buildings to dry.

Laundering events did not follow a set daily or weekly pattern, but was carried out when a pile of used clothes had accumulated. *Roles and norms*: most washing we observed was carried out by senior or junior women. Often laundry was a shared chore; cooperation among multiple daughters meant that laundry could be done more quickly. Unlike the majority of household chores, young unmarried men were expected to do their own laundry until they were married. School children were mostly expected to launder their own school uniforms daily. *Competencies*, mothers described how children could be taught to wash clothes from about the age of 9, by having them participate in the daily wash, so they would learn by doing.

Variants: The most common variant observed was laundering done at the water source rather that at the house. This might be at a lake, communal pump or at the Water Centre. In these cases, water was used less sparingly. However, laundry off-site was limited to households that either did not have restrictions on women being out of the home or to younger members of the family. In one compound the head of household always sent his laundry to a laundry service.

The inferred *Setting Objective* was to maintain clothes in a clean and presentable state using water and detergent as sparingly as possible.

Handwashing

The typical handwash *stage* was again the open courtyard of the compound. *Props* used were buckets of water, not specifically designated for handwashing, a dipper to pour water over hands and sometimes local bar soap, usually held in the small basket of bathing items. The observed handwashing *routine* was accomplished by dipping hands into reserved leftover soapy water, rubbing and then rinsing with a small amount of clean water. However, when asked to demonstrate handwashing on video, women respondents took much more care, sent a child to fetch soap or laundry powder, lathered up hands and had a second person pour clean water over her hands to rinse them, again catching the waste water in a bowl for later use. *Norms:* participants claimed to wash hands with soap before and after meals, after the toilet and before feeding a baby, however, observation and previous studies of handwashing suggests that these injunctive norms rarely reflect actual practice (V. Curtis et al., 2009; Matthew C Freeman et al., 2014a).

Variants Muslim households employed the small plastic kettles that are commonly used for ablutions as *props* to pour water onto hands. The kettle makes it easy to wash hands without the help of another person.

The inferred *objective* of the handwash setting was to remove grease and dirt when hands get sticky with minimal use of soap and water.

4. Discussion

Findings

Water use behaviour related to drinking, dish washing, laundering and handwashing was deeply entrenched within commonly-practiced behaviour settings. Similar patterns were also observed for bathing and cooking water use (data not shown). Across all behaviours, we observed standard *stages*, *infrastructure*, and *props* that were used according to established *norms* and *roles*, which generated standard *routines*.

Routines

Few new patterns of water use behaviour emerged after covering about 10 households. The rapidity with which data saturation was achieved suggests that these behaviours are highly stereotypical, with similar *infrastructure*, *props* and *norms* generating similar water use *routines* in each setting. We noted minimal variation based on water source; regardless of the availability of water to the household, common settings generated similar *routines*. We surmise that these standing patterns of behaviour emerged as efficient means of cooperating within compounds to manage scarce water resources. These patterns are stable and spread because people copy; a) what works, b) what most people do, c) what successful people do, and d) what they infer that other people think they should do, i.e., *norms* (Bicchieri et al., 2017; Henrich, 2015).

Stage and Infrastructure

We saw little variation in the *stage* and *infrastructure* of these water use settings. Many households were in the process of improving their housing, graduating from construction with mud and thatch to concrete block and galvanised sheeting. However, unlike many emerging countries of similar GNP, little progress was being made on providing piped water to enable citizens to connect more closely

and easily to water. Despite differences in water access within and across communities, variation in types of water supply outside of the household had little observable impact on the household water use setting. Water was always treated as a scarce resource because it always came with non-negligible monetary or labour costs for purchase and/or for transport.

Water use is unlikely to increase substantially until piped water is available on the plot, or even better, inside the home (White et al., 1972). This is when major health benefits accrue, largely through improved hygiene behaviour (Prüss-Ustün et al., 2014).

Props

Households used a wide variety of drums, basins, vessels and jerry cans for water storage and many smaller vessels for water dipping and handling. These were washed often and handled hygienically, especially for drinking water. The lack of handwashing with soap after the toilet constituted probably the biggest threat to disease transmission via water in the home (V. Curtis & Cairncross, 2003; M. C. Freeman et al., 2014b). When hand washing did take place, it occurred using bowls of soapy water left over from laundry or dish washing. Though using pre-used water should help to remove pathogens, there remains a gap in the literature as to the disease risk of the re-use of water for handwashing. One prop that was observed to facilitate handwashing was the ‘kettle’ shaped plastic vessel, used mostly in Muslim households for ritual ablutions.

Competencies

The ways in which behavioural competencies were described as being transmitted were similar across behaviours, with mothers teaching children at the earliest possible age, by having them participate, through explicit teaching (showing them what to do), by punishing deviations and by supervising them while they carried out the behaviour. Failure to accomplish the behaviour correctly

once it had been learnt, and wastage of water, in particular, would then be corrected by scolding. Family members knew how to accomplish 'proper' handwashing with soap and could demonstrate this more elaborate ritual, suggesting that they had learnt the technique in school, or from a health worker, however everyday handwashing was much more peremptory.

Roles and norms

In these water use settings, the major players were predominantly female, as has been observed across the world (Bisung & Elliott, 2017; V. Curtis, l986; White et al., 1972). The exception was when technology was involved. For example, one male was observed bring jerry cans of water home on a motorbike, and the MeRuwa who delivered water using carts were exclusively male. The physical workload associated with water hauling and cleaning tasks appeared great (in contrast with sedentary, technologically-enhanced Northern lifestyles). Families expected, and extracted, a heavy workload from junior members and unquestioning obedience in carrying out the tasks. Girls, in particular, were expected to work harder than boys in heavy water-related tasks such as hauling water and laundry. The recent advent of universal schooling has, however, been a boon for girls and boys, because families prioritised time for children's school work over their labour.

Norms about water use related to avoiding waste, and courtesy to elders and visitors. Water was always used carefully and sparingly, with a hierarchy of the cleanest water being kept for drinking, then for cooking, then for cleaning dishes, then for bathing -- patterns which have been noted elsewhere in Africa and in Asia (Almedom & Odhiambo, 1994; Pinfold, 1990; White et al., 1972). Less clean, used or soapy water could be used for other cleaning tasks, usually followed by a clean water rinse. Children were expected to treat water as a scarce resource and to not play with, or otherwise waste it. Most of these norms support the efficient accomplishment of setting objectives by regulating use of this precious resource. Due to its value, water was also used as a symbol of

hospitality and respect; offered systematically to visitors and with a genuflection by females to elders.

Public Health Implications: Settings Disruptions

What are the implications of these findings for our research problem, namely for how to improve water use for public health?

The original rationale for the Water Centres, as with many kiosk models that offer filtered and treated water, was that they would improve health through providing pure water. However, for water destined for consumption, we found that most people already had well entrenched *routines* of using borehole water for drinking, which was carefully segregated and protected. This situation changed during the rainy season, when rainwater, which was considered pure as it 'comes from heaven', was used for all purposes. However, even this was collected and segregated in ways that minimized potential contamination. Water Centres may therefore not be providing a major reduction in disease risk through the improved *quality* of the water that they provide.

A more important disruption to water use *routines* may be to improve the *quantity* of water used by households. A number of studies have documented a relationship between the quanitity of water used by a household and distance to the source. Once the time taken to collect water exceeds a few minutes (typically around 5 minutes or 100m for a round trip), the quantities of water collected decrease to plateau of minimal usage (Cairncross & Feachem, 1993). As a result, healthy personal and domestic hygiene activities such as handwashing, bathing, dishwashing and laundry are restricted. An implausibly large number of Water Centres would have to be built within 5 minutes from each house for them to occasion the kinds of changes in water use behaviour that can impact public health. A more health-beneficial form of settings disruption might be for the centres to operate commercial piped distribution systems that bring water direct to premises. In the long term we argue

that reticulated water systems with in-house connections, at an affordable cost, should be the aim of public policy in Sub Saharan Africa.

Handwashing with soap is potentially the most beneficial hygiene behaviour that could be adopted by this population to improve their health (Matthew C Freeman et al., 2014a). The general level of knowledge and belief about the importance of handwashing was high, but actual practice was rare, as has been found in many locations (V. Curtis et al., 2009; Matthew C Freeman et al., 2014a). Whilst improved water availaibility is key to improving handwashing behaviour, in the meantime, developing *props* to reduce the physical difficulty of handwashing could assist. Some good results have also been shown by modifying the *stage* by painting a route from toilet to handwashing location on the ground (Grover et al., 2018; Hulland et al., 2013) and by installing mirrors above handwash locations.

Beyond an immediate health benefit, Water Centres also aspire to improve wellbeing by lessening the water-related workload for women. We confirmed in this study that the major haulers and users of water were still women in these households. Water use *settings* could be disrupted further by shifting the workload roles away from females to males. Males tend to differentially appropriate new technologies, for example, by using motorbikes to fetch water (V. Curtis, l986). New *props* such as semi-automated washing machines marketed to males might alleviate women's domestic workload. Marketing efforts that seek to make male hauling and handling of water a norm could also be envisaged. We learnt how the advent of universal primary education has led to a lessening of domestic workload for some young girls. New opportunities for study for women, either through Health Clubs (J. Waterkeyn & Cairncross, 2005) (J. A. Waterkeyn & Waterkeyn, 2013) or through mobile technologies for women who are not presently allowed to leave their home compounds to study, might provide a rationale to lessen their *roles* in domestic chores. Water Centres are aiming to

enhance the *MeRuwa* water delivery service, which also helps to reduces women's *role* in water hauling.

The behaviour settings methodology

As behavioural scientists are increasingly noting, not all of human behaviour is under cognitive control (Bargh & Morsella, 2010; Baumeister et al., 2011; Kahneman, 2011; Wilson, 2004). Much of habitual and routine behaviour can be thought of as a response to factors in the actor's immediate environment, her or his *umwelt* (Shettleworth, 2001). If this is true, then we need new tools for capturing and understanding these non-psychological determinants of behaviour. Observing an actual stream of behaviour in context can provide much insight, but if we are to identify behavioural determinants and disrupt them, so as to predictably alter behaviour, then we need to define and capture these factors systematically. We have postulated, defined and, in this study, employed, *stage, infrastructure, props, roles, routines*, *competencies* and *norms* as a set of environmental behavioural determinants with their origins in behavioural settings theory. We then used them to discern *routines* of water use behaviour in rural and peri-urban Nigeria.

Behaviour settings theory and our modified set of component factors provided a straightforward tool that was easily employed to capture these factors through direct observation, photography and video clips on mobile phones. Because the method did not rely on self-report of behaviour or on interrogation about determinants, they avoided the cognitive biases of talk-based methods such as the questionnaire or the focus group. Hence interviewees did not have to strive to give the 'right answer' to questions, or to try to post-rationalise factors which they who simply did not know nor recognise. Rather we looked simply at what is observable, and in some case utilized these practices to frame targeted questions for discussion.

Ethnographic interviewing – such as the "grand tour" questions (Spradley, 2016) and participant observation are commonly employed methods for documenting and understanding daily activities. These can provide a powerful tool for understanding meaning, emic knowledge, and larger cultural systems. However, these methods often involve subjective interpretation, are difficult to execute well when relying on field staff or interpreters, and often fail to provide data granular enough to capture detailed routines. By contrast, this method was simple and precise to use, and fieldworkers were able to collect data with minimal training. The checklist format provided a closed-ended tool for capturing the information needed to characterise behaviour settings while minimizing recall and courtesy bias.

Because we were trying to capture all of the many water use behaviours within a household, data collection was time-consuming. Hence in this case, during a 1-2-hour household visit, it was not possible to capture much else beyond water use settings. However, with fewer behaviours, data capture would be more rapid. In this study our biggest problem was that, with the early achievement of data saturation, data collection became boringly repetitive. We chose to complete the study in 24 households to test the method, but for future qualitative studies with stable behaviour patterns, fewer households would be needed.

Conclusions

While we know that environments are important determinants of behaviour, there are few tools available to characterise those aspects of the social and physical environment that are relevant to behaviour. In this paper we have proposed a new way of defining and describing the relevant aspects of the *umwelt* of an individual using the behaviour settings concept. Picking out *stage, infrastructure, props, norms, roles* and *routines* allowed us to accurately and efficiently describe remarkably stable patterns of water use behaviour in this population in rural and semi-rural Nigeria. The authors'

experience suggests that there is much that is common about these behaviour settings and the routines that they engender across Sub-Saharan Africa. This may be because, in similar settings, similar solutions to daily problems will emerge, either endogenously, through energy and resource optimization processes, or because useful cultural and technological innovations tend to spread, even across a continent. If settings approaches can indeed capture such macro patterns of behaviour, independent of local psychological and cultural variation, then they may be an ideal focus for the design of large-scale public health interventions.

Behaviour settings theory provides an insightful, granular, parsimonious and largely objective means of documenting and understanding the causes of behaviour, especially when these are regular in nature. We believe that this concept has great potential both for understanding and changing behaviour in a wide range of contexts. Ethnographic studies often struggle to combine the psychological, cultural and material aspects of anthropological phenomena ranging from religious to economic practices; behaviour settings theory offers a meso-level concept within which these can be meaningfully integrated. Behaviour changers, similarly, struggle to integrate the macro- and micro-level factors impacting on target behaviours, and often ignore the physical constraints of time and place. Whilst this study took a qualitative approach, settings can be quantified, and indeed, they can be modelled. Agent-based modelling of settings *in silico* offers the exciting possibility of being able to predict how behaviour will change in response to a disruption, as agent-based models mimic the basic elements of a setting: people behaving in resource-filled environments.

In this case, using the settings approach provided a new perspective on the determinants of water use behaviour, and cast light on ways in which such fixed patterns of routine behaviour could be disrupted to improve health. We suggest that the settings toolkit has the potential to be used in both

qualitative and quantitative studies of behaviour determination, and that disrupting settings may provide a powerful means of changing behaviour for the better.

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