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

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ABSTRACT

Rationale: 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, an ecological psychological 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.

Methods: We applied 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.

Results: We found 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 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. Water kiosks are making only marginal improvements to the quantity and quality of water being used in homes.

Conclusions: 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 such behaviour.

1. Introduction

Many of the behaviours that public health professionals seek to change form part of the routine of daily life. Diet, 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. Yet, few intellectual or operational tools exist for the study of routine behaviour. In this study, we apply *behaviour settings theory* to the study of water use behaviour in relation to health in Nigeria (Barker, 1968). 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.

1.1. 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), which is typically referred to as 'formative research' (FR) (Curtis et al., 1997). But, 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 and Curtis,

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2016; Ouellette and Wood, 1998; Wood and Runger, 2016). Thus, self-report can provide an inaccurate picture of the determinants of routine behaviour, which is a major challenge for those seeking to employ systematic and theory-based approaches to the design of public health interventions.

1.2. What is behaviour settings theory?

Behaviour settings theory was first elaborated in the 1950s by the ecological psychologist, Roger 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, or 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 during assembly, music class, or 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 that meet specific objectives. Wicker (1987), 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 behavioural sequences."

Though settings theory did not survive the cognitive revolution of the 1960s, 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 its physical surroundings (Lewin, 1939). In sociology, settings have some overlap 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 (Kelley et al., 2003; Kelley and 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 – that 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). Settings theory, as we currently employ it, is underpinned by an understanding of reinforcement learning (Sutton and Barto, 1998) (i.e., behaviours that work to achieve commonly desired objectives are reinforced and hence become more likely to recurr in the particular setting, whereas those that are not, do not).

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 the recognition that physical structures and objects 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. Behaviour settings theory thus posits that individuals have *constrained agency*. Further, unlike many of the approaches discussed above, settings are easy to operationalise by capturing their observable dimensions.

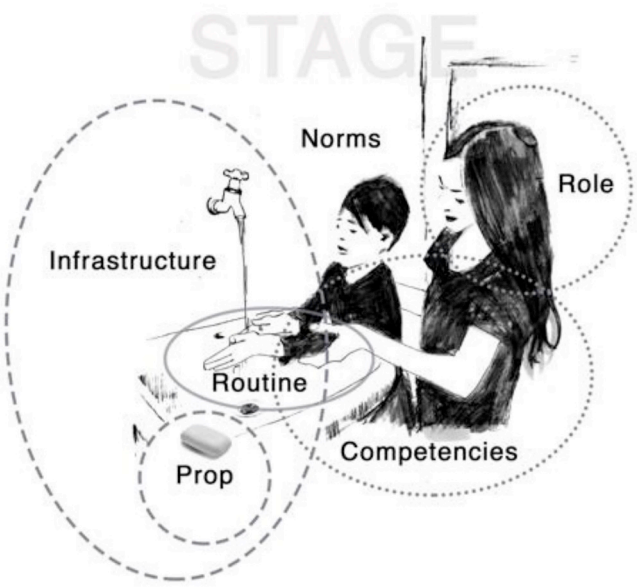

Fig. 1. A behaviour setting and its components.

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 Behavioural economics (Thaler and Sunstein, 2008), which targets automatic processes through making changes to the choice architecture, social norm change (Bicchieri et al., 2017), habit formation (Wood and 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 and 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 and 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 method section. Fig. 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 manipulates *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., a regularized sequence of behaviours, enacted in roughly the same order repeatedly, typically with little conscious attention). Table 1 gives definitions for the components of settings.

Once the role of behaviour settings in shaping specific everyday behaviours is understood, *disrupting* settings provide 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 modified the school toilet *stage* by painting brightly coloured footprints on the ground between toilets and handwash facilities. These changes disrupted the setting in such a way that

Table 1
Definitions of settings components and data collection methods.

Dimension	Definition	Data collection method
Stage	The area of the compound in which the activity took place	Direct observation Photography
Infrastructure	The durable physical elements of the setting that were employed to complete relevant behaviours	Direct observation Photography
Props	The objects manipulated to accomplish setting behaviours	Direct observation Behavioural demonstration
Roles	The cooperative strategy employed by an individual concerned with helping to accomplish the setting's objective	Direct observation Behavioural demonstration In-depth interviewing
Competencies	The embodied and cognitive skills required to accomplish an individual's role in the setting	In-depth interviews
Norms	Implicit social rules governing or relating to the accomplishment of the setting	Observation In-depth interviewing
Objective	The goal that is achieved through the setting	Deduced in the analysis
Routine	The regular sequence of events from initiation to completion of the setting	Observation Behavioural demonstration

improvements in children's handwashing behaviour were still sustained five months after the intervention (Grover et al., 2018).

1.3. Water use behaviour in Nigeria

This study applies behaviour settings theory to the issue of domestic water use in Nigeria, which 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 source of water that met the Sustainable Development Goal criteria for basic services (WHO/Unicef, 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 the risk of diarrhoeal disease by 23% (d = 0.77, 95% *CI* [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 (Curtis et al., 2000; Wolf et al., 2014). Secure access to reliable water sources is also associated with reduced psychosocial stress and improved emotional well-being and quality of life (Bisung and Elliott, 2016, 2017; Stevenson et al., 2012; Wutich and Ragsdale, 2008).

As is common in many low-income settings where the public sector has not met local water needs, small water enterprises may play an important role (Huttinger et al., 2017). These range from informal, private vendors who sell water from 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 the establishment of water kiosks. Labeled locally as Water Centres, these are operated by a local non-governmental organization and are intended to be financially sustainable businesses. The Centres treat water that is pumped from deep bore wells by solar power and then sell it 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 in this context.

2. Method

2.1. Study site

Our study took place in December 2016 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 collect water from 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.

2.2. The household environment

Most houses in the study area were located in walled compounds that were shared with related families (those of co-wives or other relatives). Houses were usually single storied and made of concrete blocks with galvanised iron roofs, and compounds were generally earth-floored. 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 entirely 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 their compound, or only under close supervision.

2.3. Sampling

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

2.4. Data collection

In prior scoping work, we identified seven categories of routine water use behaviour, which were: drinking, cooking, dishwashing, bathing, handwashing, laundry, and 'other' (e.g., example, watering plants, processing of agricultural products). Data about these activities

were 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 concerned 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 scientists/translators. Data were also collected concerning water choice factors and the operations of the Water Centres (reported elsewhere).

2.5. 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* 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 that was new emerging from the data, was achieved about halfway through the data collection. Because water use behaviour settings were remarkably similar across all 23 households, our analysis presents the patterns of behaviour that appeared in the majority of cases and then discusses deviations from this pattern.

2.6. Ethics and consent

Ethical permission for the study was granted by The London School of Hygiene & Tropical Medicine's Research Ethics Committee (No 11,580). 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; therefore, they were replaced by the head of a neighbouring household.

3. Results

Fourteen of the 23 study households reported getting water from the Water Centre, of which six used it exclusively. Those living closer than a 5 minute walk from the centre were somewhat more likely to use the Water Centre exclusively or partially ($\chi^2 = 8.1394$, $p = 0.017$) than those living farther away.

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

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 a neighbour or local kiosk by a child sent out for that purpose. Some female respondents reported the occasional purchase of cooled sachet water to drink 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 then rapidly decanted into drinking water vessels and used as described above.

3.2. 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 a small sachet of detergent powder in a plastic soap dish. Few items of cutlery were employed. The typical *routine* was for cooking and eating dishes to be collected into a basket after a meal which was 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. Mothers, however, explained that this *norm* had changed because children were often busy with school and homework. The inferred dishwashing setting *objective* was 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.

Variants of this setting included the observation of a small boy and a small girl (aged around 5), individually washing up their own dishes

after eating and a report from one senior male that he always helped his wife to wash up. In another household, a live-in aunt had the role of dishwasher.

3.3. 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 large plastic or tin 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 goal 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 ocurred when a pile of used clothes had accumulated. 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 most household chores, it was a *norm* for young unmarried men to do their own laundry until they were married. School children were also mostly expected to launder their own school uniforms daily. Mothers described how children could become *competent* at washing clothes from about the age of 9, which was achieved by having them participate in the wash, so that they would learn by doing. The inferred setting *objective* was to maintain clothes in a clean and presentable state, using water and detergent as sparingly as possible.

The most common **variant** observed was laundering being carried out at the water source rather that in the compound. This *stage* might then be at a lakeshore, beside a communal pump or in the laundry area of a the Water Centre. In these cases, water was used less sparingly. Offsite laundry was limited by *norms* to households that did not have restrictions on women being out of the home. In one compound, the head of the household always sent his laundry to a laundry service.

3.4. Handwashing

The typical *stage* for handwashing 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* took place after hands became grimy and was accomplished by dipping hands into reserved leftover soapy water, rubbing and then rinsing with a small amount of clean water. When asked to demonstrate handwashing on video, however, women respondents took much more care, sending a child to fetch soap or laundry powder, lathering up their hands and asking a second person to pour clean water over her hands to rinse them, and again catching the waste water in a bowl for later use. Although participants claimed to wash hands with soap before and after meals, after the toilet, and before feeding a baby, it was clear from the observations that these were injunctive *norms* that did not accord with actual practice, as has been observed in multiple studies (Curtis et al., 2009; Freeman et al., 2014). The inferred *objective* of the handwash setting was to remove grease and dirt when hands got sticky, with minimal use of soap and water.

Variants that were observed included handwashing by Muslim households employing the small plastic kettles that were commonly used for ablutions as *props* to pour water onto hands. The kettle made it easier to wash hands without the help of another person.

4. Discussion

4.1. Findings

Water use *routines* related to drinking, dishwashing, laundering, and handwashing were deeply entrenched within the behaviour settings of these low-income Nigerian households. We also observed similar patterns of repeating routine behaviour for water use in bathing and cooking. Across all behaviours, we observed standard *stages*, *infrastructure*, and *props* that were used according to established *norms* and *roles*, which generated standard *routines*. We discuss these below.

4.2. Routines

We observed few new water use *routines* 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 because people repeat what works, and the patterns spread because people copy what most people do, what successful people do, and what they infer that other people think they should do (i.e., *norms*) (Bicchieri et al., 2017; Henrich, 2015).

4.3. 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. Yet, despite differences in water availability 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 – coming, as it did, with non-negligible monetary or labour costs for purchase and/or for transport. In Nigeria, unlike many emerging countries of similar GNP, little progress is being made on improving piped water supply. Water use behaviour is unlikely to improve substantially until piped water is available on the plot, or even better, inside the home (White et al., 1972), which is when major health benefits accrue, largely through improved hygiene behaviour (Prüss-Ustün et al., 2014).

4.4. 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, which were washed often and handled hygienically, especially when water was intended for drinking. The lack of handwashing with soap after using the toilet probably constituted the biggest threat to disease transmission via water in the home (Curtis and Cairncross, 2003; Freeman et al., 2014). When handwashing did take place, it occurred to remove grime, and it employed bowls of soapy water left over from laundry or dishwashing. Though 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. The kettle-shaped plastic vessel, used mostly in Muslim households for ritual ablutions, was a helpful *prop* that could be used more widely to facilitate handwashing.

4.5. 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 (i.e., showing them what to do), by punishing deviations and 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. Yet, having this *competency* did not affect actual daily practice, which was much more peremptory.

4.6. Roles and norms

In these water use settings, the *role* players were predominantly female, as has been observed across the world (Bisung and Elliott, 2017; Curtis, l986; White et al., 1972). The exception was when technology was involved. For example, one male was observed to bring jerry cans of water home on a motorbike, and the *MeRuwa* who delivered water using carts were exclusively male (Curtis, 1986). The physical workload associated with water hauling and cleaning tasks appeared to be substantial (in contrast with Western sedentary, technologically-enhanced 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, altered this *norm*, because families prioritised children's time for school work over their other chores.

Norms about water use related to avoiding waste and contamination, 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, and then for bathing—patterns that have been noted elsewhere in Africa and in Asia (Almedom and 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 the use of this precious resource. Water was also used as a symbol of hospitality and respect, offered systematically to visitors and with a genuflection by females to husbands or elders.

4.7. Public health implications: settings disruptions

The original rationale for the Water Centres, as with other kiosk models that offer filtered and treated water, was that they would improve health through providing pure water. Contrarily, for water destined for consumption, we found that most people already had entrenched *routines* of using locally available 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. Yet, even this water 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. Many studies have documented a relationship between the quantity 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 10minutes for a round trip), the quantities of water collected decrease to a plateau of minimal usage (Cairncross and 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 a 5-min walk from each house 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 households. 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 (Freeman et al., 2014). The general level of knowledge about the importance of handwashing was high, but actual practice was rare, as has been found in many locations (Curtis et al., 2009; Freeman et al., 2014). The best way to facilitate handwashing is to have water on tap in the home, however, the in the meantime, developing *props* to reduce the physical difficulty of handwashing perhaps similar to the 'kettles' already in use in some households, could assist. Alterations to the *stage*, such as painting brightly coloured reminders between toilets and handwashing locations, as successfully implemented in Bangladeshi schools (Grover et al., 2018; Hulland et al., 2013), or by installing mirrors above handwash locations might prompt the adoption of new handwashing *routines*.

Beyond an immediate health benefit, the Water Centre project also aspired to improve well-being by lessening the water-related workload for women. In this study, we confirmed that the major haulers and users of water were still women in these households. Water use settings could be disrupted further by reassigning *roles* from females to males. Males tend to differentially appropriate new technologies, for example, by using motorbikes to fetch water (Curtis, 1986). 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 women's education, either through Health Clubs (Waterkeyn and Waterkeyn, 2013) or 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.

4.8. Behaviour settings theory as a theoretical advance

As behavioural scientists are increasingly noting, not all human behaviour is under conscious cognitive control (Bargh and Morsella, 2010; Baumeister et al., 2011; Kahneman, 2011; Wilson, 2004). Much of habitual and routine behaviour is, in fact, an automatic response to factors in the actor's immediate environment, her or his *umwelt* (Shettleworth, 2001), as exemplified here concerning water use behaviour in rural Nigeria. Although a huge intellectual effort has gone into studying the psychological factors that are thought to control behaviour (e.g., most models in health psychology), relatively little effort has gone into exploring behaviour's non-psychological determinants. If Barker and Schoggen (1973) were right to that 90% of everyday behaviour can be predicted if one knows the setting and the role being played within it, then we may have been looking in the wrong place for the main determinants of everyday behaviour.

We believe that settings theory, which situates the determinants of most behaviour in the immediate social and physical environment of the individual, and in their history of learning what works to achieve commonly sought objectives, offers a major theoretical advance. Our modified version of settings theory has the further advantage of drawing from recent perspectives in cultural sociology, social psychology, and reinforcement learning theory (Goffman, 1974; Shove et al., 2012; Tharp and Gallimore, 1988). Using the settings perspective has the practical advantage of compelling the investigator to focus on

actual behaviour and its observable determinants, which is unusual in the social sciences. We suggest that settings theory could usefully be adopted by behavioural scientists both for qualitative studies, as carried out here, and also for quantitative studies. Such future work is likely to lead to further development and modification of settings theory.

The approach that we have set out here is practical and offers new tools for capturing and understanding the non-psychological determinants of behaviour. Observing an actual stream of behaviour in its context can provide useful 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. Use of the settings tool requires little expertise or inference, and is broadly applicable to a wide range of behaviours, making observations by different people of different kinds of behaviour more comparable. The approach set out here could easily be adopted, not just by health psychologists aiming to change behaviour, but also by others concerned to document and understand behaviour, including anthropologists, sociologists, clinical and organisational psychologists, product designers, and marketers.

4.9. The behaviour settings method: advantages and limitations

Our modified set of component factors for capturing the dimensions of water use behaviour settings 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, it avoided the cognitive biases of talk-based methods such as questionnaires or focus groups. Hence, interviewees did not have to strive to give the 'right answer' to questions, or to try to post-rationalise factors that they who simply did not know nor recognise. Rather, we looked at what is observable, and, in some cases, utilized these practices to frame targeted questions for discussion. Of course, it is inevitable that the presence of an observer will have some influence on what is observed (McCambridge et al., 2014). But the stable repeating patterns that we observed here suggest we were observing normal habitual behaviour, with only a few adjustments tuned to the presence of the visitor.

Ethnographic interviewing – such as the "grand tour" questions (Spradley, 2016) and participant observation are commonly employed methods for documenting and understanding daily activities and can provide a powerful tool for understanding meaning, emic knowledge, and larger cultural systems. But, 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 minimising 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. Therefore, in this case, during a one to 2 h household visit, it was not possible to capture much else beyond water use settings. With fewer behaviours, however, data capture would be more rapid. In this study, our biggest concern was that, with the early achievement of data saturation, data collection became tedious and repetitive. We chose to complete the study in 23 households to test the method, but for future qualitative studies with stable behaviour patterns, fewer households would be needed.

The settings described here were relatively simple, involving few actors in behaviours that required relatively little skill in a context that is not embedded in complex institutions. It remains to be seen how and if the settings framework can usefully be adapted to understand routines in more complex environments.

5. Conclusions

Whereas 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 study, 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 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. These similaritries may arise because, in similar settings, similar solutions to daily problems will emerge, either endogenously, through reinforcement learning that optimises energy and resource utilisation, 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 propose that this concept has great potential for both understanding and for changing behaviour in a wide range of contexts. Ethnographic studies often struggle to combine the psychological, cultural, and material aspects of anthropological phenomena; 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 study, using the settings approach provided a new perspective on the determinants of water use behaviour and reveals 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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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2019.112398.

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