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THE BEHAVIOURAL DESIGN SOLUTION SPACE: EXAMINING THE DISTRIBUTION OF IDEAS GENERATED BY EXPERT BEHAVIOURAL DESIGNERS

C. K. E. Bay Brix Nielsen, P. Cash and J. Daalhuizen

Abstract

Understanding how human behaviour can be influenced through design is an increasingly important topic in research and industry. Despite distinct theoretical recommendations for behavioural design ideation there is little research examining the solution space. Thus, this research provides an in depth examination of the distribution of intervention ideas generated by expert behavioural designers in five brainstorming sessions. The findings show a distribution of ideas often at odds with theoretical expectations. As such, this study contributes important implications for research and practice.

Keywords: design methods, design creativity, design practice

1. Introduction

Behavioural design is an approach that aims to deliver interventions that replace undesired behaviour with desired behaviour (Cash et al., 2017a). As such, behavioural design focuses on achieving a desired behavioural effect by carefully designing the 'user-intervention'-interaction. To create successful interventions behavioural designers must both be able to consider the behavioural mechanisms of target users, the context in which the 'user-intervention'-interaction takes place, as well as possible outcomes of the interaction itself. Therefore, behavioural design builds on multiple theories such as human-product interaction theory (e.g. Akrich, 1992; Latour, 1992) established in the field of design, however primarily on social and cognitive psychology of human behaviour (e.g. Prochaska, 1979; Bronfenbrenner, 1989) established in the field of psychology. This makes the behavioural design solution space both complex, and distinctly different from other design approaches.

Typically, behavioural design problems/solutions focus on how to get target users to either do something e.g. exercise more often, or stop doing something e.g. stop throwing trash on the streets. By focusing on preventing or enabling behaviour, the behavioural design solution space can be considered in terms of a number of dimensions. First, solutions often involve diverse interactions between user(s), products and systems in everyday life (Rantanen and Domb, 2010; Andreasen et al., 2015). Second, these interactions can occur both before, during, and after the behaviour of interest (Miltenberger, 2003). Third, these interactions influence behaviour in different ways according to different behavioural strategies (Tromp et al., 2011). Each of these three dimensions reflects an aspect of behavioural theory that interfaces with design. However, how these various aspects actually manifest in generation of behavioural design solutions is poorly understood. Thus, designers are challenged with understanding the whole behavioural design solution space available to them and subsequently developing effective interventions.

Given this research gap, this study examines the generated ideas in five different, real world brainstorming sessions in an established and successful behavioural design consultancy in order to better

understand how the various aspects of the behavioural design solution space are treated by expert practitioners. The study investigates the distribution of ideas in three different dimensions (intervention form, time of active intervention, and intervention influence type). Based on this investigation a first insight is given into the treatment of the behavioural design solution space, and subsequently implications are derived for how effective ideation might be supported in this context.

The three dimensions are further described in Section 2. The research framework and method for the study are explained in Sections 3 and 4, respectively. The findings are presented in Section 5, discussed in Section 6, and Section 7 elaborates the limitations. Lastly, the study is concluded in Section 8.

2. Theoretical background

Behavioural design as a way of designing behaviour change is first explained by Norman in the 1980's (Norman, 1988). Since then, multiple researchers have addressed behavioural design from different, but close related, angles, including Kahneman's (2011) Two systems, Cialdini's (2007) Influence, Sunstein and Thaler 's (2008) Nuding, Fogg's (2009a) Persuasive design, and Tromp et al.'s (2011) Social design. The field of behavioural design is currently growing (Niedderer et al., 2017), and over the past years multiple researchers have addressed the need for additional studies on the topic (e.g. Fogg, 2009b; Tromp and Hekkert, 2014) as well as the need for validated behavioural design methods to increase the success of applying behavioural design in design practice (e.g. Wendel, 2013; Cash et al., 2017a). However, no existing framework explicitly defines the potential solution space. As such, Sections 2.1-2.3 introduce and explain the three dimensions (intervention form, time of active intervention, and intervention influence type) treated in this study.

2.1. Intervention form

In behavioural design, solutions designed to create a desired behavioural effect are often referred to as triggers (e.g. Fogg, 2009), cues (e.g. Wendel, 2013), or interventions (e.g. Cash et al., 2017a); from which the latter is used throughout this article. The purpose of designing interventions is to break undesired patterns of human behaviour (Wendel, 2013) and/or facilitate desired behaviour (Norman, 1988; Sunstein and Thaler, 2008; Tromp et al., 2011). The desired behavioural effect is achieved by 'user-intervention'-interaction, and the behavioural effect will often be achieved by multiple, different interventions existing in a given context (Fogg, 2009b; Tromp et al., 2011). As such, 'user-intervention'-interaction(s) can take place on multiple levels as multiple interventions will co-exist in a given context. Specifically, physical products are generally characterised from component level (e.g. Suh, 1998) to system level (e.g. Sosa et al., 2003). In behavioural design, no framework connects 'user-intervention'-interaction to an explicit set of product/solution levels, however, somewhat like physical products interventions can generally be understood in levels of "parts", "products", and "systems", based on Andreasen et al. (2015) and Rantanen and Domb (2010). Apart from dealing with physical solutions, e.g. road signs (Tromp et al., 2011), behavioural design also deals with immaterial solutions e.g. education programs (Fogg, 2009b). As such, in this study, physical as well as immaterial solutions are included across "parts", "products" and "systems".

2.2. Time of active intervention

The concept of time and timing plays a big role in behavioural design highlighted by e.g. Fogg (2009b), who argues that an adequate combination of motivation, ability and interventions (triggers) must co-exist at the right moment for a desired behaviour to take place. Further, Wendel (2013) explains how a chain of consecutive behavioural steps related to the undesired/existing behaviour pattern must be considered in order to successfully design and introduce interventions. As such, in behavioural design desired or undesired behaviour should be considered in terms of a chain of behavioural steps, to increase the chances of achieving desired behavioural effects (Tromp et al., 2011; Wendel, 2013). Although, the exact temporal scope of consideration has not been established in behavioural design, it is at least accepted that designers must consider the moments before, during, and after an existing behaviour occurs/desired behavioural effect should occur. Given this constraint, Miltenberger's (2003) ABC-model describes behaviour in three steps: "antecedent" (prior to behaviour), "behaviour", and

"consequence" (post to behaviour). This forms a fundamental model of behaviour that can be leverage by designers (Cash et al., 2017a). However, existing theory does not support the differentiation of timing i.e. an interaction one month before a current undesired behaviour is considered to be in the same category (antecedent) as an interaction active one hour before. Thus, since no framework decomposes the timeframe for activation of interventions, this study uses Miltenberger's (2003) ABC model.

2.3. Intervention influence type

In order to achieve a desired behavioural effect interventions are either designed to encourage desired behaviour or discourage undesired behaviour (Tromp et al., 2011). To do so, behavioural designers can apply multiple different influence techniques, e.g. feedback mechanisms (Sunstein and Thaler, 2008), or scarcity (Cialdini, 2007). More generally interventions can either be designed to function implicitly (hidden) e.g. installation of high tables that seduce people to stand, or explicitly (apparent) e.g. a speed bump that can damage the car (Tromp et al., 2011). Here, implicit interventions will often trigger automatic behavioural mechanisms, while explicit interventions will often trigger reflective behavioural mechanisms (Sunstein and Thaler, 2008; Kahneman, 2011). Although, other frameworks describe various influence types e.g. MINDSPACE (Dolan et al., 2012) and the behaviour change wheel (Michie et al., 2011), Tromp et al. (2011) offers, to the authors knowledge, the most complete and fully realised framework in the behavioural design context. Tromp et al. (2011) bring together four types of influence: "decisive" (strong & hidden), "seductive" (weak & hidden), "coercive" (strong & apparent), "persuasive" (weak & apparent), which is used in this study to examine the generated intervention ideas in terms of intervention influence type.

3. Research framework

As a starting point in answering the research need this study examines the generated ideas in five different, real world brainstorming sessions in an established and successful behavioural design consultancy. This forms the basis for investigating the distribution of ideas in three different dimensions of the solution space (intervention form, time of active intervention, and intervention influence type). These three dimensions are operationalised in our research framework. As such, this research is explicitly theory building with respect to behavioural design methodology (Eisenhardt and Greabner, 2007). The three dimensions are drawn from the literature outlined in Sections 2.1-2.3, and are summarised below:

- Dimension 1 - Intervention form: "part", "product", and "system" (Rantanen and Domb, 2010; Andreasen et al., 2015).
- Dimension 2 - Time of active intervention: "antecedent", "behaviour", and "consequence" (Miltenberger, 2003).
- Dimension 3 - Intervention influence type: "decisive", "seductive", "coercive", and "persuasive" (Tromp et al., 2011).

4. Method

As there is little prior theory and few empirical studies in the area of behavioural design ideation, this research adopts a theory building approach (Eisenhardt and Greabner, 2007). Given this, a case-based method is used to deliver in-depth insights suitable for theory building (Yin, 2013).

The case company has extensive experience with behavioural design work consulting on a diverse range of behavioural design interventions in conjunction with many diverse companies and organisations. These include both small, medium, and large-sized companies from the public as well as private sector. The company consists of approximately 15 employees with competences ranging from psychology to engineering design to software development. The participants in all sessions could be considered 'expert' designers in the context of behavioural design, each having extensive industrial experience. Further, the company could be considered successful as it has continued to grow both in terms of revenue and number of employees. As such, the case company was well-suited to examine the generated ideas with respect to how the three dimensions of the behavioural design solution space are treated by expert practitioners.

The data was collected during five ideation sessions (S1-S5) of which the topics represents a broad range of intervention contexts representative of the variety of projects found in the case company. All sessions were observed in 2016. The five sessions are summarised in Table 1.

Table 1. Overview of observed ideation sessions (S1-S5) for five different projects

	S1	S2	S3	S4	S5
Topic	Illegal parking	Purchase/sell routines	Product sales of [product]	Software support for purchase and use of [product]	Software to increase organisational employee health
Length	01:32:26	00:53:16	00:54:25	00:58:20	01:25:27
Employees present	4	7	5	3	3

4.1. Data collection

A research team of two researchers, of which one is an author of this paper, observed and recorded the five brainstorming sessions across five different projects (S1-S5) in the case company, see Table 1. All sessions were conducted according to the company's existing ideation practices, which consisted of an introduction to the topic of ideation presented by 1-2 project leaders followed by free ideation across all employees present, including the project leader(s). The research team was invited to observe the sessions, following the set-up illustrated in Figure 1. Each session was video recorded to allow for later protocol analysis. Secondary to the observations, the research team interviewed five employees including the CEO to establish an understanding of the company and its behavioural design practices, and contextualise the findings from the observed ideation sessions.
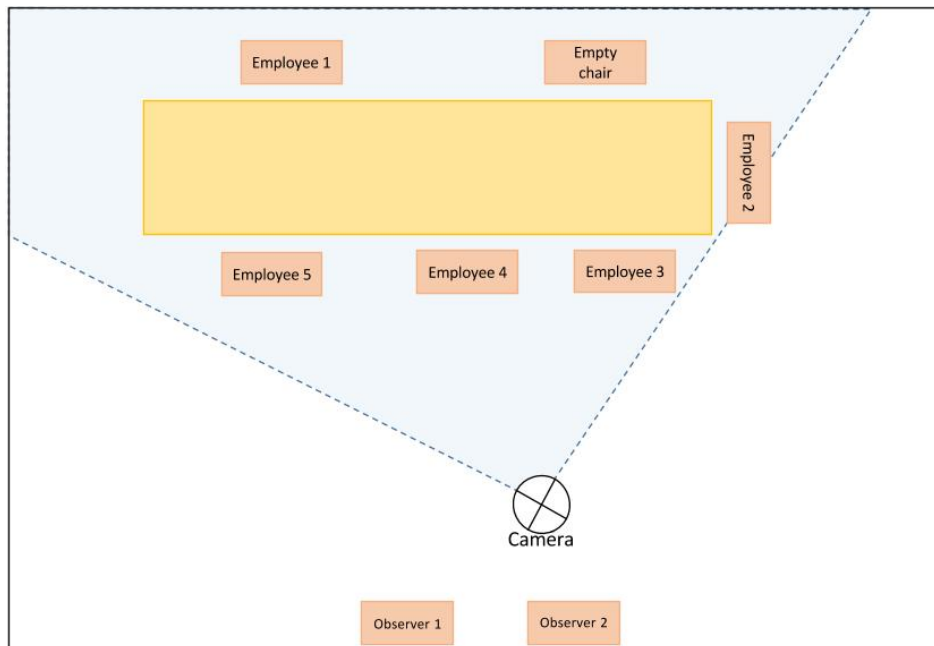

Figure 1. Observation set-up

4.2. Coding and analysis

Given the focus of the research, the video data is coded with respect to the observed ideas. Thus, the unit of analysis for evaluating the exploration of the behavioural design solution space in each session is the 'intervention idea'. For simplicity, a characterisation of a distinct idea is adopted as an 'actionable object-verb associated with a potential solution' following the discussion by Cash and Štorga (2015). Further, in this study 'intervention ideas' are defined as ideas that can be described with a distinct intervention form, time of active intervention, and intervention influence type, simultaneously. As such, in the study only ideas that could be assigned exactly one code in each of the three behavioural design dimensions was defined as 'intervention ideas'. Following the research framework presented in Section 3, the three dimensions (intervention form, time of active intervention, and intervention influence type) are operationalised as shown in Table 2.

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Table 2. Operationalization of codes

Dimensions	Code name	Code tag definition
Dimension 1 Intervention form	Part (Pa)	An individual piece of a solution/an intervention. *E.g.: "a LED" or a piece of text/information, e.g. "cyclists in here"*
	Product (Pr)	A cohesive solution/intervention consisting of one discrete product. *E.g.: "a sign", "a clip card to parking lots", "product package"*
	System (Sy)	A cohesive solution/intervention consisting of multiple products, or the product's relation to stakeholders. *E.g.: "a rotation system for parking lots", "a range of product packages", "the boss order the employees to use the app"*
Dimension 2 Time of active intervention	Antecedent (A)	The solution is active before the unwanted behaviour would potentially have happened. *E.g.: "make better space for cyclist", "a reminder in the user's calendars saying you should perform action X in 1 hour"*
	Behaviour (B)	The solution is active in the moment the unwanted behaviour would potentially have happened. *E.g.: "sign at parking spot entry showing where there is empty parking spots", "awareness zones at door entrances"*
	Consequence (C)	The solution is active after the potential behaviour has happened/would potentially have happened. *E.g.: "if you park legally, you participate in a contest", "buy for X, and get Y back"*
Dimension 3 Intervention influence type	Decisive (De)	Strong & implicit interventions: when a solution/intervention makes the unwanted behaviour impossible to perform, and/or when a solution/intervention build on human tendencies for automatic behaviour. *E.g.: "red-coloured awareness zones", "parking lot gates"*
	Seductive (Se)	Weak & implicit interventions: when a solution/an intervention creates optimum conditions for a wanted behaviour, and/or induces wanted behaviour through physiological processes. *E.g.: "create a nice environment", "install a coffee machine in the tunnel"*
	Coercive (Co)	Strong & explicit interventions: when a solution/an intervention uses negative consequences (e.g. pain, shame, punishments etc.) or explicit barriers to decrease unwanted behaviour. *E.g.: "fines", "block access cards if employees park illegally"*
	Persuasive (Per)	Weak & explicit interventions: when a solution/an intervention uses positive consequences (e.g. happiness, rewards etc.), provides argumentation, and/or suggests actions to increase wanted behaviour. *E.g.: "text on signs", "people who park legally are in a lottery"*

Each idea is coded in three steps, as illustrated in Figure 2. Each dimension of codes is applied independently, and ideas coded with exactly one code in all three dimensions e.g. "a reward" [Pr; C; Per] qualified as intervention ideas, and was included in the findings (marked as 'coded' in Table 3). The flow diagram in Figure 2 show the coding procedure, where each idea was assigned a code in each of the three dimensions [Pa/Pr/Sy; A/B/C; De/Se/Co/Per]. If none or multiple codes applied e.g. the idea "reduce number of cars" [?; A; De/Se/Co/Per] it did not qualify as an intervention idea, as was excluded from the final findings (marked as 'other' in Table 3).
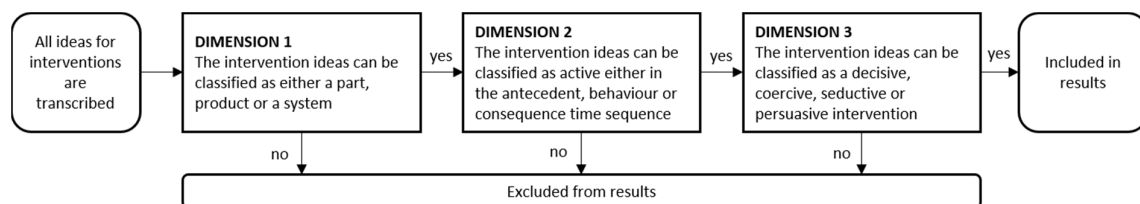

Figure 2. Flow diagram of coding approach

5. Findings

An overview of the coded intervention ideas is provided in Table 3. All intervention ideas are divided into "coded" (ideas that qualified as intervention ideas and was included in the final findings) and "other" (ideas that did not qualify as intervention ideas and was excluded from the final findings) following Figure 2. As such, "other" do not show in Figure 3-5. Importantly, the excluded ideas represent less than 10% of the total, as such, the coding applied in this research is considered sufficient to cover the majority of ideas found in the data, thus these results provide a suitable foundation for subsequent analysis.

Table 3. Overview of coded intervention ideas

	Intervention ideas in total [coded/other]	Dimension 1 Intervention form			Dimension 2 Time of active intervention			Dimension 3 Intervention influence type			
		Pa	Pr	Sy	A	B	C	De	Se	Co	Per
S1	115/7	40	30	45	40	43	32	7	26	22	60
S2	68/8	21	14	29	35	6	23	5	11	8	40
S3	108/13	31	27	50	67	21	20	3	36	1	68
S4	132/12	68	19	45	57	71	4	29	43	31	29
S5	67/6	25	5	37	29	9	29	6	11	15	34
In total	419/40	185	95	206	228	150	108	50	127	77	231

In the following section, the number of intervention ideas in each category (Pa, Pr, Sy; A, B, C; De, Se, Co, Per) in each dimension (intervention form, time of active intervention, and intervention influence type) is visualised is separate figures (Figure 3-5). The number of intervention ideas are visualised separately due to a current lack of theory explaining interaction effects between the dimensions.

Figure 3 shows the distribution of intervention forms; "parts", "products", and "systems". The first column shows the aggregate distribution for all ideas across the five sessions; the next five columns show the distribution for S1 to S5, respectively. The results show that the majority of generated intervention ideas across all five brainstorming sessions are either "systems" or "parts", while a minority are "products".
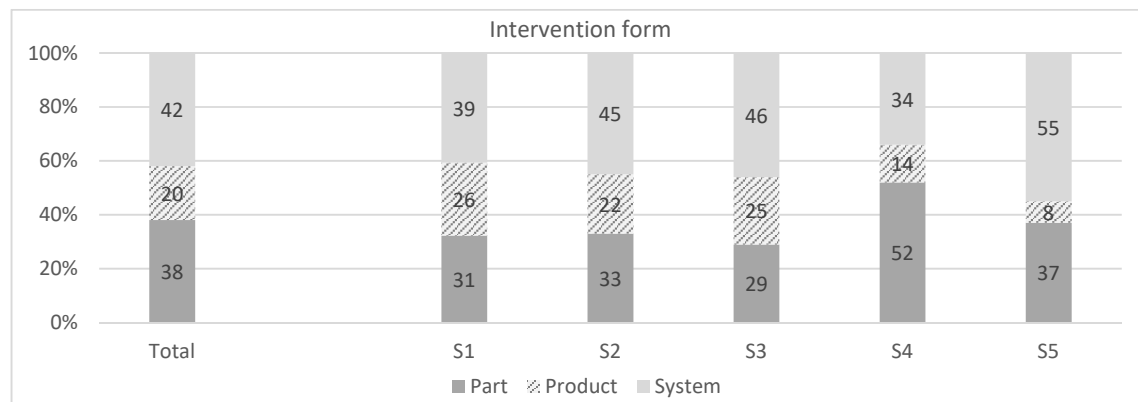

Figure 3. Distribution of generated ideas - dimension 1 ("part", "product", and "system"); Percentage of ideas per category is indicated in the respective bars

Figure 4 shows the distribution of time of active interventions; "antecedent", "behaviour", and "consequence". The first column shows the aggregate distribution for all ideas across the five sessions; the next five columns show the distribution for S1 to S5, respectively. The results show that the majority of the generated intervention ideas would be active in the "antecedent". However, in S1 and S4 a slight majority of the generated ideas would be active in the "behaviour", as only a minority would in S2, S3 and S4, where "consequence" is equally or more represented. Apart from a large number of generated intervention ideas that would be active in the "antecedent", the representation of "behaviour" and "consequence" varies substantially between the five sessions.
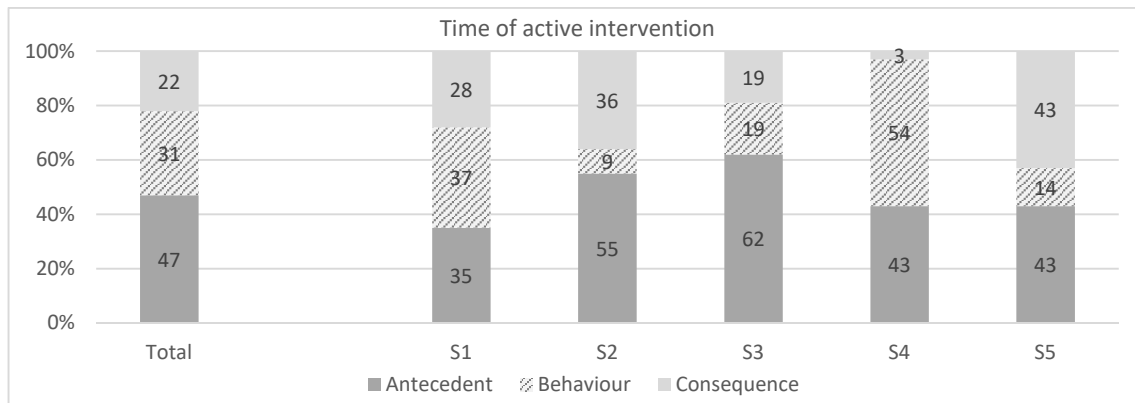
Figure 4. Distribution of generated ideas - dimension 2 ("antecedent", "behaviour", and "consequence"); Percentage of ideas per category is indicated in the respective bars

Figure 5 shows the distribution of intervention influence type; "decisive", "seductive", "coercive", and "persuasive". The first column shows the aggregate distribution for all ideas across the five sessions; the next five columns show the distribution for S1 to S5, respectively. The majority of the generated intervention ideas in all sessions apart from S4 are using a "persuasive" strategy. In general, many of the generated ideas uses a "seductive" strategy. Fewer uses a "coercive" strategy, and especially the "decisive" strategy is little represented. The number of each of the four strategies varies between the five sessions apart from S4, where the strategies are most evenly represented.
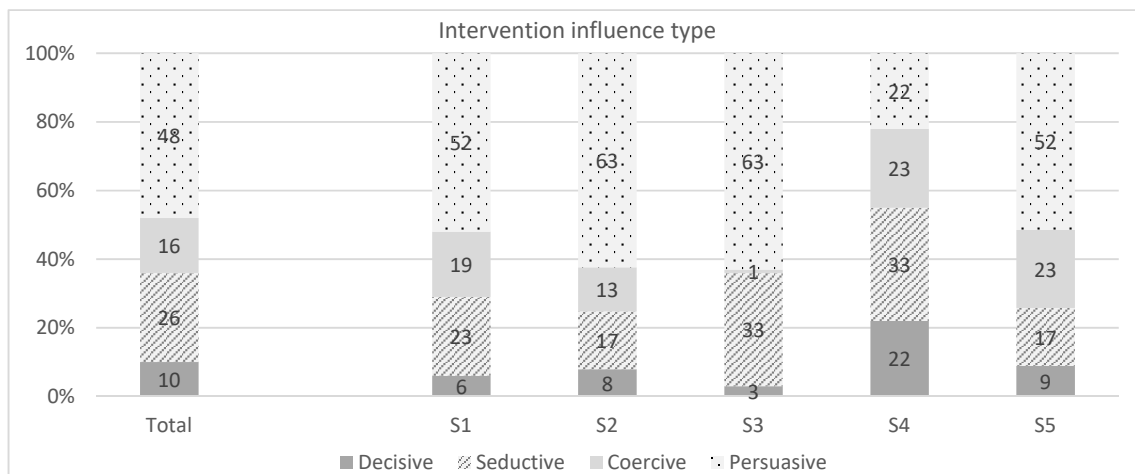

Figure 5. Distribution of generated ideas - dimension 3 (decisive, seductive, coercive, and persuasive); Percentage of ideas per category is indicated in the respective bars

6. Discussion

Section 6.1-6.3 discusses the distribution of generated intervention ideas presented in Section 5, separately.

6.1. Dimension 1 (intervention form)

The distribution of generated intervention ideas in dimension 1 (intervention form) weights towards "parts" and "systems", with few "products". Although no prior studies have empirically described the ideal distribution of "parts", "products" and "systems" generated in behavioural design brainstorming sessions, there are two main expectations for the distribution. First, looking logically at physical products one product usually consist of multiple parts (components), e.g. a flashlight that amongst other parts consist of a light source, batteries, and casings. As such, high number of "parts" in the findings is

not a surprising finding. However, when multiple products are considered, often identical parts are used in multiple distinct products as known from product architectures. In this study, this is for example seen with the "part" "*telling people to try out the other parking lot*", which is used across "products" like "[telling people to try out the other parking lot by] *a text message service*" and "[telling people to try out the other parking lot by] *signs with text*". Nevertheless, in this study "products" are less represented compared to both "parts" and "systems" across all 5 sessions. Second, as mentioned earlier, both Fogg (2009b) and Tromp et al. (2011) argue that multiple interventions often co-exist in a given context. Following this argument, in a given context, one or more intervention "parts", intervention "products", and intervention "systems" will often co-exist as a holistic solution. Even though this does not provide a clear expectation for an adequate distribution of behavioural design intervention ideas, it implies that all three intervention forms should be represented in the findings. Therefore, the most interesting finding in dimension 1 is that the distribution in S1-S3 somewhat align with each other, whereas the distribution in S4 and S5 is show a low representation of "products", and a high representation of "parts" and "systems", respectively. As such, the distribution of generated intervention ideas somewhat aligns and somewhat highlight a discrepancy between expected distribution based on limited behavioural design theory and the actual distribution in this study in dimension 1.

6.2. Dimension 2 (time of active intervention)

The distribution of generated intervention ideas in dimension 2 (time of active intervention) weights towards intervention ideas that would be active in the "antecedent". As for dimension 1, no prior studies have empirically described an ideal distribution of "antecedents", "behaviours" and "consequences" generated in behavioural design brainstorming sessions. However, there are two main theory driven expectations for the distribution of intervention ideas. First, Wendel (2013) highlights that to achieve successful interventions the timing of its introduction in the behaviour chain is crucial, and the steps both prior to and post of the plausible 'user-intervention' interaction should be mapped. Further, as mentioned before both Fogg (2009b) and Tromp et al. (2011) argue that interventions often function in a system consisting of multiple interventions that activate over time. Therefore, a somewhat equal distribution of "antecedents", "behaviours" and "consequences" are to be expected across the generated intervention ideas. As such, it is interesting to see a majority of "antecedents". However, as mentioned before, in this study Miltenberger's (2003) ABC-model is operationalised as "behaviour" covering the 'user-intervention' interactions in the moment of the target behaviour; whereas "antecedent" and "consequence" cover a longer period of time. This may explain the low representation of "behaviours" compared to "antecedents", however, it does not explain the low representations of "consequences". As such, the distribution of generated intervention ideas highlights a discrepancy between expected distribution based on behavioural design theory and the actual distribution in this study in dimension 2.

6.3. Dimension 3 (intervention influence type)

The distribution of generated intervention ideas in dimension 3 (intervention influence type) weights towards "persuasive" intervention influence types, followed by "seductive", and with little representation of "coercive", and especially "decisive" influence types. As with both dimensions 1 and 2, no prior studies have empirically described an ideal distribution of "persuasive", "seductive", "coercive" and "decisive" intervention strategies. However, there are again two main theory driven expectations for the distribution of intervention ideas. First, Tromp et al. (2011) argue that interventions should be considered with respect to all four influence types as the combination of intervention form, influence type and target users impacts the chances of success. This argument aligns with both Wendel (2013) and Fogg (2009a,b) who highlight the importance of assessment of the target users' motivations and abilities in order to successfully apply intervention influence strategies. Therefore, it is expected to see all four intervention influence types represented in the generated intervention ideas. As such, very high numbers of "persuasion", combined with the very low numbers of "seductive" and "decisive" intervention influence types are a surprising result. Second, as explicit (apparent) punishments are naturally included in "coercive", and explicit (apparent) rewards are included in 'persuasive', the high number of "persuasive" and low number of "coercive" influence types seen in dimension 3 aligns with Tromp et al.'s (2011) suggestion to prioritise encouragement over discouragement of behaviour. Further,

Kahneman (2011), Sunstein and Thaler (2008), Fogg (2009a), Tromp et al. (2011) and Cash et al. (2017b) all argue that behavioural design should build on both automatic and reflective behavioural mechanisms. As such, since "coercive" and "persuasive" intervention influence types are apparent (primarily reflective), it is surprising that they are represented high compared to "seductive" and "decisive" influence types (primarily automatic). Again, the distribution of generated intervention ideas highlight a discrepancy between expected distribution based on behavioural design theory and the actual distribution in this study in dimension 3.

7. Limitations

There are two main limitations to this study. First, the qualitative observation study conducted allows the authors to get a deep understanding of five brainstorming sessions providing an initial insight into the generated intervention ideas in real world behavioural design projects and how this aligns with theory. The results are limited to the observed consultancy and the five projects covered. However, the company has extensive experience with behavioural design work, and the sessions represented a range of intervention contexts representative of the variety of projects found in company. As such, the case company was well-suited, and the projects observed appropriate to initially examine how the distribution of intervention ideas generated through current design practice aligns with behavioural design theory. Second, as no existing frameworks exist with respect to the whole behavioural design solution space, the study operationalises current theory on the three chosen dimensions in exploration of the collected dataset and assessment of the findings. For example, in dimension 3, Tromp et al. (2011) point out that one must be careful when labelling interventions with an influence type as the intended influence is not necessarily equal to what the user perceives. However, this study aims to examine how the generated intervention ideas are distributed using current behavioural design practice and how that aligns with theory, and for this purpose the intended influence strategies are adequate.

8. Conclusion

This study separately examined the generated ideas in five different, real world brainstorming sessions in an established and successful behavioural design consultancy in order to better understand how the various aspects of the behavioural design solution space are treated by expert practitioners. To do so the generated intervention ideas of five, real world ideation sessions observed in a successful behavioural design consultancy was examined. The study examined the extent to which the observed designers generated ideas across three dimensions derived from existing literature: 1) intervention form (parts / products / systems), 2) time of active intervention (antecedent / behaviour / consequence), and 3) intervention influence type (decisive / seductive / coercive / persuasive). The examined ideas included 419 intervention ideas, and showed discrepancies between expectations derived from theory and the actual distribution of the intervention ideas generated by expert behavioural designers in real world projects. In particular the non-equal distribution of "antecedents", "behaviours", and "consequences" with high variation between S1-S5 in dimension 2, and the high representation of "persuasive" combined with a low representation of both "coercive" and "decisive" influence types in dimension 3 where surprising findings. Overall these results point to the need for further studies on the subject enabling better assessment of intervention ideas both in design practice and in behavioural design research. Also, development of behavioural design support methods is needed to support behavioural designers to better operationalize the three dimensions in their design practice.

Acknowledgments

References

Akrich, M. (1992), "The De-Scription of Technical Objects", In: Bijker, W.E. and Laws, J. (Eds.), *Shaping Technology/Building Society: Studies in Sociotechnical Change*, MIT Press, Cambridge, MA, pp. 205-224.
Andreasen, M.M., Hansen, C.T., and Cash, P. (2015), *Conceptual Design: Interpretations, Mindset and Models*, Springer, Cham. https://doi.org/10.1007/978-3-319-19839-2

Bronfenbrenner, U. (1989), "The developing ecology of human development: Paradigm lost or paradigm regained", *Biennial meeting of the Society for Research in Child Development (SRCD), Kansas City, Missouri, April 27-30, 1989.*

Cash, P.J. and Štorga, M. (2015), "Multifaceted assessment of ideation: using networks to link ideation and design activity", *Journal of Engineering Design*, Vol. 26 No. 10-12, pp. 391-415. https://doi.org/10.1080/09544828.2015.1070813

Cash, P.J., Hartlev, C.G. and Durazo, C.B. (2017a), "Behavioural design: A process for integrating behaviour change and design", *Design Studies*, Vol. 48, pp. 96-128. https://doi.org/10.1016/j.destud.2016.10.001

Cash, P.J., Holm-Hansen, C., Olsen, S.B., Christensen, M.L. and Trinh, Y.M.T. (2017b), "Uniting individual and collective concerns through design: Priming across the senses", *Design Studies*, Vol. 49, pp. 32-65. https://doi.org/10.1016/j.destud.2017.01.002

Cialdini, R.B. (2007), *Influence: The psychology of persuasion,* HarperCollins Publishers, New York.

Dolan, P., Hallsworth, M., Halpern, D., King, D., Metcalfe, R. and Vlaev, I. (2012), "Influencing behaviour: The mindspace way", *Journal of Economic Psychology*, Vol. 33 No. 1, pp. 264-277. https://doi.org/10.1016/j.joep.2011.10.009

Eisenhardt, K.M. and Graebner, M.E. (2007), "Theory building from cases: Opportunities and challenges", *Academy of Management Journal*, Vol. 50 No. 1, pp. 25-32. https://doi.org/10.5465/amj.2007.24160888

Fogg, B.J. (2009a), "Creating persuasive technologies: an eight-step design process", *Proceedings of the 4th International Conference on Persuasive Technology (Persuasive '09), Claremont, California, USA, April 26-29, 2009*, ACM, New York. https://doi.org/10.1145/1541948.1542005

Fogg, B.J. (2009b), "A behavior model for persuasive design", *Proceedings of the 4th International Conference on Persuasive Technology (Persuasive '09), Claremont, California, USA, April 26-29, 2009*, ACM, New York. https://doi.org/10.1145/1541948.1541999

Kahneman, D. (2011), *Thinking, fast and slow*, Farrar, Straus and Giroux, New York.

Latour, B. (1992), "Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts", In: Bijker, W.E. and Laws, J. (Eds.), *Shaping Technology/Building Society: Studies in Sociotechnical Change*, MIT Press, Cambridge, MA, pp. 225-258.

Michie, S., van Stralen, M.M. and West, R. (2011), "The behaviour change wheel: a new method for characterising and designing behaviour change interventions", *Implementation science*, Vol. 6 No. 1, pp. 42-52. https://doi.org/10.1186/1748-5908-6-42

Miltenberger, R.G. (2003), *Behavior modification: Principles and procedures*, Cengage Learning, Wadsworth, Belmont, California.

Niedderer, K., Clune, S. and Ludden, G. (2017), *Design for Behaviour Change: Theories and practices of designing for change*, Routledge, London, UK. https://doi.org/10.4324/9781315576602

Prochaska, J.O. (1979), *Systems of psychotherapy: A transtheoretical analysis*, Dorsey Press, Homewood, Illinois.

Rantanen, K. and Domb, E. (2010), *Simplified TRIZ: New problem solving applications for engineers and manufacturing professiona*ls, CRC press.

Sosa, M.E., Eppinger, S.D. and Rowles, C.M. (2003), "Identifying Modular and Integrative Systems and Their Impact on Design Team Interactions", *Journal of Mechanical Design*, Vol. 125 No. 2, pp. 240-252. https://doi.org/10.1115/1.1564074

Suh, N.P. (1998), "Axiomatic design theory for systems", *Research in engineering design*, Vol. 10 No. 4, pp. 189-209. https://doi.org/10.1007/s001639870001

Sunstein, C. and Thaler, R. (2008), *Nudge: Improving Decisions About Health, Wealth, and Happiness*, Yale University Press, New Haven, London.

Tromp, N. and Hekkert, P.P.M. (2014), "Social implication design (SID): A design method to exploit the unique value of the artefact to counteract social problems", *Proceedings of the Design Research Society Conference (DRS 2014): Design's big debates- Pushing the Boundaries of Design Research, Umeå, Sweden, June 16-19, 2014,* Umeå Institute of Design, Umeå, Sweden, pp. 584-597.

Tromp, N., Hekkert, P. and Verbeek, P.P. (2011), "Design for socially responsible behavior: a classification of influence based on intended user experience", *Design Issues*, Vol. 27 No. 3, pp. 3-19. https://doi.org/10.1162/desi_a_00087

Wendel, S. (2013), *Designing for behavior change: Applying psychology and behavioral economics*, O'Reilly Media Inc., Sebastopol, California.

Yin, R.K. (2013), *Case study research: Design and methods*, Sage Publications.

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