Simon's scissors and ecological psychology in design for behaviour change

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Abstract

This paper introduces a series of working papers (Lockton 2011a,b and 2012a-f) providing a background literature review of different disciplinary perspectives on *behaviour*, informing the development of the *Design with Intent toolkit* (Lockton, Harrison and Stanton 2010a,b). In the first section of the paper, Herbert Simon's 'scissors' metaphor, and the relationship between context, cognition and behaviour are discussed, while the remaining sections introduce some ecological psychology perspectives relevant to design for behaviour change, including Barker's behaviour settings, ecological interface design and Gestalt psychology principles.

1 Simon's scissors: context and cognition

> "Human rational behaviour is shaped by a scissors whose blades are the structure of task environments and the computational capabilities of the actor."
>
> Herbert Simon, 'Invariants of human behaviour'. *Annual Review of Psychology*, 41, 1990, p.1-19.

This paper introduces a series of working papers (Lockton 2011a,b and 2012a-f) providing a background literature review of different disciplinary perspectives on *behaviour*, informing the development of the *Design with Intent toolkit* (Lockton, Harrison and Stanton 2010a,b). Between them, the papers cover a diverse set of approaches to behaviour—and how it might be influenced—with practically applicable implications and insights for designers extracted. In the first section of the paper you are reading, parallels with—and implications of—the relationship between context, cognition and behaviour are discussed, while the remaining sections introduce some ecological psychology perspectives relevant to design for behaviour change.

1.1 A useful metaphor

A framework which has proven useful in structuring the research process is to consider relevant disciplinary perspectives loosely along the lines of Simon's 'behavioural scissors' (Figure 1) mentioned in the

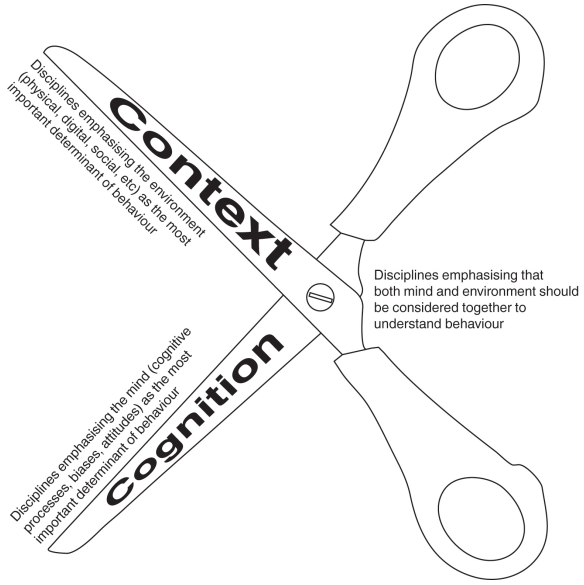


Figure 1: An interpretation of Herbert Simon's 'behavioural scissors'

above quote, simplifying the two blades to be concerning 'context' and 'cognition' respectively (following Clark, 2009). 'Environment' and 'mind' might be further simplifications[1]. The point behind Simon's metaphor is that just as a pair of scissors needs both blades to operate, understanding behaviour requires an understanding of both context and cognition: focusing exclusively on one blade will not give a complete picture. Design is well placed to address 'where the blades cross'—dealing with both context and cognition.

Of course, all cognition necessarily occurs *in* a context, so the scissors are not a perfect metaphor for 'how behaviour occurs'.[2] Nevertheless, for helping to structure a literature review, the two blades have been helpful in providing a simple 'shape' to the disciplines reviewed, especially since the scope of the research has expanded over the course of the Design with Intent project.

1.2 Lewin's equation

Returning to Simon's scissors, one obvious parallel is with 'Lewin's equation' (Lewin, 1935, p.241), part of his *field theory* (1943):

$$B = f\left(P, E\right)$$

According to this, behaviour, in any situation, is a function of the person and his or her environment: "Lewin believed that the stream of activity we call human behaviour resulted from the continuing interaction of factors within the person... with other external factors as they are perceived in a given behavioural setting." It is "the constellation or pattern of inner and outer influences that he experiences" that determine someone's behaviour (Ittelson et al, 1974, p.69). In Lewin's treatment, the 'environment' expressly includes social factors as well as the physical, and this approach has been taken in the structure of this literature review.[3]

[1] Along with the remainder of this paper, Lockton (2011a,b and 2012b) cover primarily the context blade, while Lockton (2012c,d) cover the cognitive blade; Lockton (2012a,e,f) cover areas perhaps in the intersection of the blades, dealing with both context and cognition.

[2] The work of Gerd Gigerenzer and colleagues (e.g. Gigerenzer and Fiedler, 2004; see Lockton 2012d) provides an explicit treatment of the fit between the blades: cognition and decision-making in context via the use of heuristics.

[3] Lewin also made use of the concept of *channel factors*, "apparently minor but actually important details" in the context of situations which have the effect of being "critical facilitators or barriers" (Ross and Nisbett, 1991, p.10). In a sustainable

Jackson (2005, p.89), focusing specifically on consumer behaviour, summarises the context / cognition distinction (though in the opposite order) in terms of how branches of psychology take different approaches: "[T]here are—broadly speaking—two identifiably different kinds of approaches to understanding consumer behaviours... The first ('internalist') perspective carries an implicit assumption of consumers as atomistic agents autonomous of social structure, while the second ('externalist') perspective sees consumers as constrained operators programmed (or at least heavily influenced) by external forces beyond their comprehension or control."

1.3 The fundamental attribution error

The *fundamental attribution error* (e.g. Ross and Nisbett, 1991) is relevant here. This is, essentially, the finding that "[w]e overestimate the degree to which other people's behaviours are due to their personal traits, and underestimate the degree to which they are caused by the situation" (Winter & Koger, 2004, p.66). From a design point of view, this might be expressed in terms of assumptions that users will behave in a certain way—e.g. wasting energy—because they are intransigent, or have the wrong attitude, rather than because contextual factors make it easy to waste energy, or difficult to save it.

Conversely, when explaining variances in our *own* behaviour, we often emphasise context factors:

> "For example, when Deborah [Winter] sees a colleague drive his car two blocks to the library, she explains the behaviour as laziness and a lack of awareness about environmental issues; she's less likely to attribute it to the possibility that he has to carry 14 books back. But when she drives her car around the campus to the library, it's obviously due to the situational demand of returning so many books. "I'm not lazy, but he is"" (Winter & Koger, 2004, p.66).

Lockton, Harrison and Stanton (2012) explore some of the assumptions that designers make when 'modelling' users with a view to influencing their behaviour.

1.4 Modelling behaviour

Many approaches to influencing behaviour emphasise one blade or the other—context or cognition. They try to change the context in which people behave (e.g. making it easier or harder to behave in a particular way) or try to change people's thinking, so that they behave or don't behave in a particular way. Design often combines both approaches—it can address both the context of behaviour and the way that people perceive and make decisions about what to do.

Some more recent models of behaviour follow Lewin and do include both context and cognition, such as the *A*-*B*-*C* model (Guagnano et al, 1995; Stern, 2000)—developed in the context of a study of recycling—which incorporates both attitudes (A) and 'external conditions' (C) as determinants of behaviour (B). The model results in an "inverted U-shaped function" (Stern, 2000, p.415) with the contextual factors C 'trumping' personal factors A as a determinant of behaviour B when they are very strongly positive or negative, but A being the dominant variable affecting B as C tends towards neutrality. Lockton (2012c) addresses the importance of attitudes in behaviour change—and how designers can affect them—in more detail, including discussion of models such as the Theory of Planned Behaviour (which emphasises cognitive rather than contextual factors), while Lockton (2012d) looks in more detail at cognitive biases and decision-making.

The remainder of this paper introduces some aspects of ecological psychology—very much part of the 'context blade'—and how they might be relevant to design for behaviour change. Lockton (2011a,b and

behaviour context this may describe some of the oft-recognised gaps between 'pro-environmental attitudes' and actual behaviour in practice (see Lockton 2012c). For example, someone holding an empty soft drink can may have the intention to recycle it, but if a recycling bin is not available (the channel factor), it is likely it will not be recycled.

2012b) go into more detail on other aspects of context, how the physical and social environment and the structure of situations is modelled as affecting behaviour, in a number of psychological and other disciplines. In each case, implications for designers are extracted—techniques and insights which it may be possible to apply through design to influence behaviour.

2 Ecological and environmental psychology

Environmental psychology "deals with the reciprocal relationships between humans and the built and natural environment" (Bell et al, 1996, p. v), which is broad enough a definition to encompass a range of areas of research. Of the fields covered in this series of working papers, most of what has been organised along the 'context' blade of Simon's scissors—with the probable exception of discussions of digital architecture and social context—would be considered to be within environmental psychology's scope.

Ecological psychology is usually defined more narrowly, with its treatment of behaviour arising from two main (separate) origins: Barker's work on *behaviour settings* and Gibson's on *affordances*. Affordances are probably the most fundamental ecological psychology principle from a 'design and behaviour' perspective, and as such are covered in detail in Lockton (2012b).

Within the scope of this section, only certain ideas from environmental and ecological psychology will be considered where they are directly applicable to a design context.

2.1 Behaviour settings and environmental stimuli

Barker's work on behaviour settings (Barker, 1968) explored how specific 'settings' comprise both a 'physical milieu' and 'standing patterns' of collective behaviour. For example, a school classroom at a particular moment "is bounded in space and time and has a structure which interrelates physical, social and cultural properties so that it elicits common or regularized forms of behaviour. Barker's objective was to determine the relationships between what he calls the extraindividual pattern of behaviour—that is, the behaviour that all people en masse reveal in a behaviour setting—and the structural properties of that setting" (Ittelson et al, 1974, p.70). He uses the term *synomorphic* to describe behaviour that is similar in structure to the physical milieu—in a classroom with chairs in it, sitting behaviour is synomorphic while lying down is not.

Price (1976) describes attempts to develop taxonomies of behaviour settings based on shared characteristics, one of the advantages of which would be the ability to predict people's behaviour in new settings, given knowledge of the social and cultural characteristics of the situation. From a design for behaviour change perspective, probably the most immediately salient idea to draw from Barker's work is the idea that designing particular settings could elicit particular behaviours, if the setting is similar to ones in which the desired behaviours are normally expressed. Some work on problems such as reducing dissatisfaction (and aggression) in hospital accident and emergency waiting areas (e.g. Design Council, 2011) involves effectively trying to change the behaviour setting to one less likely to elicit undesirable behaviour.

Chein (1954) felt that the 'stimulus' part of the then-dominant stimulus-response psychology (see Lockton 2011a) had been under-explored theoretically, and aimed to "pull together a schema for taking better account of the environment than is customary" (Chein, 1954, p.115). In his definition, a stimulus is "whatever is capable of initiating a change in the stream of activity; it is, so to speak, a release or trigger mechanism" (p. 117). Beyond simply triggering a response, however, Chein classifies a number of other behaviour-related functions stimuli can have. They can be: *goal objects*, "objects or situations which can serve as need satisfiers" (p.119); *noxiants*, which are painful or unpleasant; supports, "features

of the environment which make particular behaviours feasible" (p.121); *constraints*, "features of the environment which preclude particular behaviours, make their occurrences less likely, or limit their variability" (p.121); or *directors*, features "which tend to induce specific directions of behaviour" (p.123). Overall, the presence or absence of these components in an environment determines the degrees of freedom available to a person.

It is not clear the extent to which Chein's different categories of components are mutually exclusive (e.g., 'directors' would seem to include or overlap with many of the others), but they parallel many of the other concepts relevant to design which emerge from the literature. Comparing Fogg's Behaviour Model (see Lockton 2012f), supports and constraints could be seen as the environmental parts of 'ability', a prerequisite for particular behaviours to occur—and the goals and noxiants as environmental contributions to Fogg's 'motivation' component. Directors and stimuli in general (in Chein's definition) have parallels with Fogg's 'triggers'.

2.2 Ecological interface design

Vicente (2002) and Burns and Hajdukiewicz (2004), among others, have developed the field of *ecological interface design* (EID), incorporating an ecological psychology perspective into the process of designing interfaces, mainly for complex systems such as nuclear power station control rooms, chemical plants and intensive care units.

Helping users to understand the affordances (Lockton, 2012b), and, especially, the constraints in their environment is an important concept within EID. The basic aim is to make interfaces "ecologically sound"—"designed to reflect the constraints of the work environment in a way that is perceptually available to the people who use it... This transparency of use, where users feel as if they are working directly with the object and not with the interface, is the 'holy grail' of interface design" (Burns and Hajdukiewicz, 2004, p.1-2).

While this goal of 'transparency' also recurs in other areas of interaction design, such as haptic and 'natural' user interfaces designed to simplify interaction (e.g. Microsoft's Kinect and Surface), EID focuses mainly on interfaces in 'expert' domains, where users need to deal with more information and make often safety-critical decisions based on it, without error, reducing the cognitive demand of the decision-making process by putting as much knowledge 'in the world' rather than requiring users to hold it in their heads (using Norman's (1988/2002) terminology. [4]

Burns and Hajdukiewicz present EID as an alternative approach to the user-centred design paradigm dominant in consumer product design and interaction design, concentrating on understanding and modelling the *work domain*—in particular the constraints that exist, which define and limit the human activity possible—first rather than starting with users themselves. It is argued that in many cases where systems are complex, the user-centred design practice of "asking users [what they want] doesn't work", although this portrayal of user-centred design is perhaps something of a straw man as user research methods continue to evolve.

Specifically in the context of influencing behaviour for social and environmental benefit, EID has been applied to problems including reducing energy use and encouraging moderation in gambling. Vicente (2006, p.114-8) describes Power Pig, a student project encouraging users to turn computer workstations off when not in use via a novel interface incorporating both metaphor ("a race between the computer user and the top energy conserver in the entire company") and an element of affective design (see Lockton 2012c) in the sense that the user is represented as a cartoon drawing of a pig which changes from "a

[4] Indeed, one aim is to help "users to become experts" (Burns and Hajdukiewicz, 2004, p.7) through the way that information is presented, reducing training needs and helping users develop more accurate mental models (St-Cyr and Burns, 2002). When applied to behaviour change, this has parallels with elements of the EMPOWER project, discussed in Lockton, Cain, Harrison et al (2011).

fat ugly pig representing an energy glutton, to a slim, muscular, attractive pig representing an energy conserver" as the user changes his or her behaviour.

Burns and Hajdukiewicz (2004) describe the application of EID to analyse the work domain of—and design a new interface for—a video poker game, with the aim of helping problem gamblers improve "poor decision-making behaviour" (p.240) through both a "downward spiral visualization... suggest[ing] that longer play is more problematic" (p.243), a metaphor of an "unfair race" to demonstrate that "the house always wins and odds are set deliberately to favour the house... Regardless of the situation, the house is always shown as advantaged over the patron" (p.244). In a similar vein to the pig example, a metaphor of a dog represents the gambler, "changing from a suave 'cool dog' to a 'dirty dog' rummaging through trash when the gambler has exceeded his allowable losses" (p.244). It is recognised that the gambler and the house have different objectives; this perhaps makes the gambling context more complex than the energy example. It is interesting that both examples make use of elements (such as the animal characters) widely used in a number of other behaviour change projects (e.g. Dillahunt et al's (2008) virtual polar bear) although with a different approach to analysing the 'problem' in the first place.

3 Perception and Gestalt psychology

> "Perception is of definite and probable things"
>
> William James, The Principles of Psychology, 1890, Chapter XIX

Perception is an area of considerable interest in environmental and ecological psychology, as it is in human factors research generally. Gibson's affordances and later additions and clarifications of the concept by Norman and Gaver (see Lockton 2012b) all involve questions of perception and how decisions are made (consciously or otherwise) about what actions to take based on that perception. Technological developments such as thermal imaging can allow enhanced perception or shifting of stimulus perception from one sense to another (Giacomin, 2010) with potential for influencing behaviour through new kinds of salient feedback.

Brunswik (1956) saw environmental stimuli not simply "as a source of stimulation but as a source of information from and about the environment" (Ittelson et al, 1974, p.73), in a way perhaps paralleling some of Shannon's ideas (Shannon & Weaver, 1949). In Brunswik's *ecological cue validity* model, a person perceives cues in his or her environment, which are 'sampled' and combined to make probabilistic inferences about what the actual properties of the environment are, with the inferences becoming more accurate the more sampling occurs over time in a kind of Bayesian process. Brunswik uses the metaphor of a lens which focuses (combines) the diverse cues present in an environment onto a single, resultant probability. Cues' ecological validity is "their objective trustworthiness as potential indicators of mechanical or other relatively essential or enduring characteristics" (Brunswik & Kamiya, 1953, p.20). The characteristics do not have to be purely physical: Brunswik (1956, p.50) includes "social stereotypes" within the scope of the inference process, and Hammond (1998), in explaining the differences in validity of cues suggests, for example, contrasting "the ecological validity of the cue 'height of forehead' with the cue 'vocabulary level' as indicators of a person-object's intelligence" to illustrate that one cue is probably more valid than the other.

From a pragmatic design perspective, Brunswik's cues might be seen as a kind of probabilistic perceived affordance or sum of affordances about a situation; the specific practical application might be in ensuring that the cues present in a situation are *consistent* or *aligned* in a way that suggest they are matched to the behaviour that we are trying to influence; or, indeed, simply in recognising that in an unfamiliar situation, users' perceptions of affordances may be to a degree probabilistic ("It looks like this

might do X") based on experience with analogous situations elsewhere. Design can be used to support those inferences and give users confidence in their decision-making when engaged in new behaviours.

3.1 Gestalt psychology: the behavioural environment

> "On a winter evening amidst a driving snowstorm a man on horseback arrived at an inn, happy to have reached a shelter after hours of riding over the wind-swept plain on which the blanket of snow had covered all paths and landmarks. The landlord who came to the door viewed the stranger with surprise and asked him whence he came. The man pointed in the direction straight away from the inn, whereupon the landlord, in a tone of awe and wonder, said: "Do you know that you have ridden across the Lake of Constance?" At which the rider dropped stone dead at his feet."
>
> Kurt Koffka, *Principles of Gestalt Psychology*, 1935, p.27-8

Gestalt psychology is an approach to perception which emerged in the early 20th century, not specifically focused on behaviour, but with many implications for, and applications in, design. According to Köhler (1930, p.148), "[i]n the German language... the noun 'gestalt' has two meanings: besides the connotation of 'shape' or 'form' as a property of things, it has the meaning of a concrete individual and characteristic entity, existing as something detached and having a shape or form as one of its attributes." Gestalt psychology thus deals with "what is perceived [as] the whole, whether an object, a person, an event, or a physical setting... Any event, object, behaviour or experience consists of the patterned relationship among the various parts" (Ittelson et al, 1974, p. 67-8).

Koffka (1935) uses the Lake Constance story quoted above to introduce the idea that the geographical environment (a frozen lake) was not the same as the behavioural environment which the rider perceived (a barren plain). "His behaviour was a riding-over-a-plain, but not a riding-over-a-lake," (Koffka, 1935, p.28) hence his fright upon realising what he had done. This concept—the behavioural environment—essentially means the environment as mediated by perception, central to the gestalt approach. Behaviour can only be understood by considering the environment as it is perceived, as a whole, together with the person perceiving it. There are parallels with Barker's behaviour settings (discussed above).

3.2 Gestalt psychology: the laws of perception

However, the contributions of gestalt psychology which have had most impact in design, primarily visual design, are the 'gestalt laws of perception', or 'principles of organisation', observationally derived heuristics dealing with the perception of forms and patterns and inferences drawn from them. These appear in a number of forms and have been developed and extended by authors subsequently to their original framing; Tables 1 and 2 provide a brief summary of some as commonly phrased, drawing on Wertheimer (1923), Köhler (1930), Koffka (1935), Boeree (2000), Lidwell et al (2003), Todorovic (2008) and Soegaard (2010)—in particular, some of the principles which seem to offer applicability in the design for behaviour change context.

The main applicability is in terms of influencing users' perceptions: deliberately using similarity (perhaps) to suggest that two controls should be operated together, or drawing users' attention to particular parts of an interface, or deliberately breaking symmetry to distinguish otherwise identical, adjacent controls which should be operated separately, as in the illustration of part of a nuclear power station control panel that Norman (1988/2002, p.95) uses, in which two knobs have been distinguished by fixing the handles from different beer kegs over them.

Table 1: A selection of some commonly cited gestalt principles with possible applicability to design for behaviour change

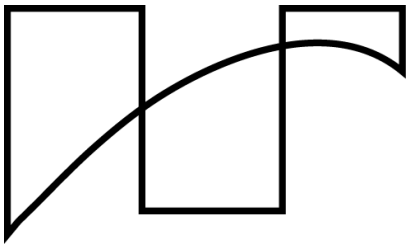
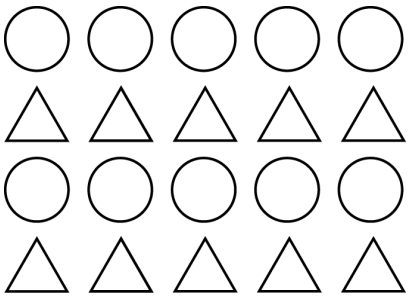
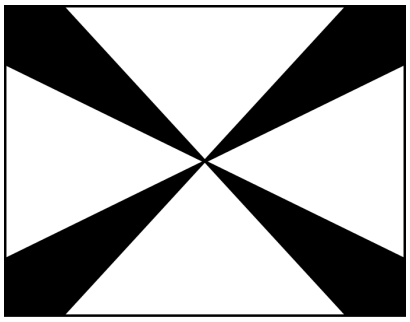
Prägnanz	Translated as 'succinctness' or 'conciseness', the law of *prägnanz* is "a tendency to interpret ambiguous images as simple and complete, versus complex and incomplete" (Lidwell et al, 2003, p. 120). The concept pervades many of the other gestalt principles—a stimulus will be perceived as being as 'good' a figure as possible.	In this image, "it is not three self-enclosed areas but rather The Factor of the 'Good Curve' which predominates." (Wertheimer, 1923) 
Proximity	The law of proximity suggests that "when we perceive a collection of objects, we will see objects close to each other as forming a group." (Soegaard, 2010)	The dots "form pairs in which spontaneously the nearer ones unite." (Koffka, 1935, p. 164)
Similarity	The law of similarity "claims that elements tend to be [perceived as] integrated into groups if they are similar to each other." (Todorovic, 2008)	"[W]e see the circles and triangles as forming four horizontal rows (or at least some configuration where triangles and circles are grouped depending on their shape). Objects similar to each other thus tend to be seen as a unit." (Soegaard, 2010) 

Table 2: Two further commonly cited gestalt principles with possible applicability to design for behaviour change

Figure-ground relationship	The principle of the figure-ground relationship "asserts that the human perceptual system separates stimuli into either figure elements or ground elements." (Lidwell et al, 2003, p.80) Generally what is perceived as the figure receives the observer's focus, but in some circumstances the relationship is unclear and can 'flip-flop' as in the famous 'Rubin vase' optical illusion.	"With exactly the same constellation of stimuli we may have two different forms, either a cross consisting of four slender arms or a cross (like that of an order) containing four large sectors." (Köhler, 1930, p.152; diagram modified to add black shading) 
Symmetry	The law of symmetry suggests that when "we see two unconnected elements that are symmetrical, we unconsciously integrate them into one coherent object" (Soegaard, 2010). "Symmetry signifies far more than mere similarity of parts; it refers rather to the logical correctness of a part considered relative to the whole in which that part occurs." (Wertheimer, 1923)	"Despite the pressure of proximity to group the brackets nearest each other together, symmetry overwhelms our perception and makes us see them as pairs of symmetrical brackets." (Boeree, 2000) 

A number of other gestalt principles and developments of them are probably also relevant, but to a lesser degree, such as the laws of closure, convexity, common fate, continuation and uniform connectedness, and some work on auditory gestalten; the overarching law of prägnanz suggests that users will identify patterns where they are present, in whichever way is simplest or most concise, thus the designer should try to ensure that these patterns are the ones intended. In some cases, the 'completeness' aspects of gestalt can be deliberately employed, e.g. Ehrnberger and Broms' (2007) 'Puzzle Switches' are patterned light switches which are visibly disordered when switched on, reminding users to switch them off when leaving the room by being obviously 'out of place' or 'unresolved' until dealt with.

Behrens (1998) suggests that "one of the reasons artists embraced gestalt theory is that it provided, in their minds, scientific validation of age-old principles of composition and page layout"; certainly, graphic designers and more recently interaction designers have internalised many of these principles to the extent that they may seem 'obvious'. Behrens also makes much the same point with gestalt's "influence in the field of psychology [itself. It] is unobtrusive in the sense that its findings have all been absorbed by more recent viewpoints and because most of the prominent gestalt psychologists have either retired or died."

4 Implications for designers

- The concept of behaviour settings suggests the possibility of redesigning particular settings to elicit particular behaviours, if the new setting is similar to ones in which the desired behaviours are normally expressed.
- Interface design could help users understand the affordances and constraints available in their environment, in a way where users "feel as if they are working directly with the object and not with the interface".
- Designers should ensure that the cues present in a situation are consistent or aligned in a way that suggest they are matched to the behaviour that it is intended to influence.
- Design can support users' inferences about a situation and give them confidence in their decision-making when engaged in new behaviours.
- Gestalt principles could be used to influence users' perceptions, e.g. deliberately using visual similarity to suggest that two controls should be operated together.
- The law of prägnanz suggests that users will identify patterns where they are present, in whichever way is simplest or most concise, thus the designer should try to ensure that these patterns are the ones intended.

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