**Hostile Scaffolding**

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## Abstract

Most accounts of cognitive scaffolding focus on ways that external structure can support or augment an agent’s cognitive capacities. We call cases where the interests of the user are served *benign* scaffolding and argue for the possibility and reality of *hostile* scaffolding. This is scaffolding which depends on the same capacities of an agent to make cognitive use of external structure as in benign cases, but that undermines or exploits the user while serving the interests of another agent. We develop criteria for scaffolding being hostile and show by reference to examples including the design features of electronic gambling machines and casino management systems that hostile scaffolding exists and can be highly effective. In cases where the scaffolding is deep and permits the offloading of significant cognitive work, hostile scaffolding exploitatively manipulates cognitive processing itself. Given the extent of human reliance on scaffolding this is an important and neglected vulnerability.

## Keywords:

Scaffolding, affective scaffolding, hostility, extended functionalism

# 1. Introduction

The standard idea of cognitive scaffolding is that things in the environment can support, simplify or otherwise beneficially transform cognitive processes just as physical scaffolding can beneficially transform the demands and risks of building construction and maintenance. Vygotsky is often credited as among the first psychologists to draw attention to what is now called cognitive scaffolding. He characterised a ‘zone of proximal development’ indicating, among other things, a learning stage where a task could be performed successfully only with a supportive guide (Vygotsky, 1978). In contemporary cognitive science ‘scaffolding’ is used to embrace both developmental supports like the guide in Vygotsky’s zone of proximal development and props and tools that the agent doesn’t learn to do without like lane markings and signs at traffic intersections. Some scaffolding, as we will see, allows significant cognitive processing to be conducted outside the agent.

Most discussion of scaffolding focuses on how it can be supportive or beneficial by reducing cognitive demands, improving reliability, facilitating co-operation, and making possible tasks that are beyond an unaided individual. We don’t dispute that such scaffolding, which we call *benign*, is real and important. Rather, we are contributing to a growing body of work drawing attention to ways that external structures can sometimes have negative cognitive and affective consequences. Aagaard (2020), for example, has argued that standard pictures of the ways that cognition extends beyond the skull tend to be ‘overly idealized’, and to presume beneficial results. He calls this the *dogma of harmony*, urges that more attention be paid to possible harms associated with extended cognition, and offers enabling bad habits, and deskilling as instances of the harms. Slaby (2016) has made a similar point about what he calls the dominance of a “user/resource model” of external structure, suggesting that affective scaffolding can have exploitative functions in workplaces. Liao and Huebner (2021) have argued that material things can contribute to oppression when their effects are biased in the same direction as, and they are causally embedded in, an oppressive system. Other relevant work includes Coninx & Stephan (2021) on mind-shaping in scaffolded affectivity, and Krueger (2021) on the contribution of spatial factors to some impairments in Autistic Spectrum Disorder. We make some remarks about salient contrasts with some of these contributions after developing a more detailed account of our own distinctive position.

Our aim here is to contribute to this growing body of work drawing attention to ways that external structures can sometimes have harmful cognitive and affective consequences. We do this by developing a distinct line of thinking focused on scaffolding. Agents that can benefit from benign scaffolding may for that reason be vulnerable. Their capacities to distribute cognitive labour, that is, might be engaged by external structure in ways that harm them. We are going to focus on a distinct sub-category of the harms, where the agent using the scaffolding is harmed, *and* another agent, one that is causally involved in the scaffolding having the properties that it does, benefits. When the effect of scaffolding on an agent is to undermine their own interests *and* serve those of another implicated agent, we call the scaffolding *hostile*. We mean hostile in the sense of Sterelny (2003), whose emphasis on hostility expressed through information is an important corrective to optimistic slogans about the world serving as ‘its own best model’ (Brooks, 1991). If hostile scaffolding is possible, it would enable a distinctive way of manipulating other agents, besides presenting misleading signals and attempting to hijack internal cognitive processes. We make no claim to exhaust the scope of scaffolding that is not benign here, only to identify an important class of cases.

In the following two sections we characterise benign scaffolding and develop criteria for hostile scaffolding. We also introduce a distinction between shallow and deep scaffolding. With that preparation in place we proceed to offer some examples and case studies, including ones drawn from contemporary machine gambling devices and casino management systems. After considering an objection, we conclude and return to the recent literature on cognitive and affective harms associated with external factors.

# 2. Benign Scaffolding

The broad idea of cognitive scaffolding is of something *external* — usually to body, but sometimes to brain — that somehow supports cognitive processes. As Clark puts it in *Being There,* “exploitation of external structure is what I mean by the term *scaffolding*.” (Clark, 1997, p45). There’s generally little appetite for regimenting scaffolding talk, which is recognised to pick out a varied collection of situated, embodied and distributed cognitive phenomena with little prospect of forming a natural kind.[[1]](#footnote-1) We propose the following inclusive and neutral – in the sense of being non-committal about who benefits from scaffolding – characterisation as a starting point: *Cognitive Scaffolding* is external structure that changes the cognitive demands of a task. In the following paragraphs we clarify how this characterisation is to be understood.

To count as *external* something should be to a significant extent beyond the ‘skull or skin’. *Structure* is an inclusive place-holder, embracing objects, mechanisms, temporally organised processes, symbolic systems, public language, and the activity of other agents. The cognitive is a large and varied category, so many kinds of *change* can be brought about by scaffolding depending on the demands (perception, memory, inference, planning…) of a task. A jacket left hanging on the bathroom door handle scaffolds remembering to dress smartly in the morning. A cook organising partly prepared ingredients in a workspace reduces search time by simplifying perception, or facilitates the construction of a pleasing regular arrangement with reduced measurement and planning (Kirsh, 1995). Hutchins describes many examples of artefacts which transform the computational demands of navigation, including the ‘three scale nomogram’ which converts multiplication and division operations relating distance, time and speed into drawing a straight line that connects two known values and crosses all three scales (Hutchins, 1995, p148). Slide rules on which several rigid logarithmic scales — some mobile in relation to others — are marked allow various computations to be performed by manipulating the scales (Hutchins 1995, chapter 3).

Although the examples above emphasise the traditionally cognitive (memory, perception, reasoning), we intend *cognitive* to be understood inclusively to embrace affective and motivational phenomena as well as more traditionally cognitive ones, and to include cases with a ‘pushmi-pullyu’ character (Millikan, 1995) where the cognitive and motivational or affective are entangled. Clothing, mementos, places, pieces of recorded music and forms of embodied activity can help occasion or sustain desired affective or motivational states, and sometimes have downstream cognitive effects (Griffiths & Scarantino, 2009; Colombetti & Kruger, 2015; Piredda, 2020; Maiese, 2016). We also stipulate that saying that scaffolding *changes* the cognitive demands of a task indicates change relative to unaided internal processing but doesn’t presume that the task could be performed unaided. We emphasise that one consequence of our characterisation is that whether something is scaffolding depends on and is restricted to a specified task and agent, and isn’t an all or nothing property of the external structure. This is appropriate: scaffolding isn’t purely environmental, but is rather relational. A slide rule is only computationally useful to someone competent to use it, and one person’s motivating exercise playlist might be another’s acoustic purgatory.

Many examples of scaffolding involve cues, labels or surface environment features: objects placed as reminders, road markings, and conventional signage for bathrooms and elevators in public spaces. While using some of these might depend on significant on-board capacities, including competence with symbols or public language, considered *as scaffolding* they are relatively superficial. Some scaffolding is not superficial – the slide rule that converts mathematical operations into physical manipulations, also requiring some numerical competence from the user, isn’t merely a favourably situated label or cue. The slide rule works because it is a concrete instantiation of a large number of structured relationships (the rigid scales) where the normal range of manipulations preserve those relationships, and because processing can loop from brain to artefact and back again. Subject to the markings being correctly read, manipulations can do significant computational work. When it matters to draw this distinction, which is very much one of degree, we’ll call the superficial scaffolding ‘shallow’ and the instances where significant processing gets done externally ‘deep’. The claim that there can be deep scaffolding is a version of the claim, in Hutchin’s (1995) language, that cognition can be genuinely *distributed*, in the sense that some significant processing takes place outside individual skulls.

Examples of deep scaffolding are readily found. Consider a month planner with days of the week arranged in regular columns or rows, with already planned activities filled in. The same set of facts could be stored on scraps of paper — one for each engagement — and kept in a bag marked ‘April’. By mapping calendar time onto spatial relationships in an orderly way, the month planner transforms tedious, time-consuming and error-prone enquiries into quick visual searches and inferences. (Compare the demands of using the bag of notes and the planner to identify two adjacent, available weekdays suitable for scheduling an event.) Nautical navigation maps on the other hand distort some aspects of physical space so that straight lines on the map pick out locations with shared directional relationships, at the cost of accurately representing scale (Hutchins, 1995, Chapter 3). Many underground train maps distort distances and directions to facilitate queries and inferences focused on topological relationships between passenger stations and different services (Kent, 2021). They make answering questions like ‘can I get to Russell Square from where I am without changing line’ easy by prioritising line-identity and passenger-centric topology. That using these calendars and maps typically requires some skill from the user doesn’t make a difference to the key point: desk planners, slide rules, some maps, numeral systems and routines for long-division, etc., are forms of deep scaffolding which depend on the structure of the scaffolding itself, and whether it successfully preserves (including under manipulation) a version of some favoured set of relationships. Being a difference of degree, this allows boundary cases. An individual spot of ant pheromone is a plausible instance of shallow scaffolding. But an accumulation of them into a *trail* can ‘carry information about direction and distance’ and, given the ants’ trail making and trail following dispositions, the intensity of a trail ‘carries information about the value of the food resource’ (Sterelny, 2003, p19). An ant pheromone trail, then, could be a boundary case between shallow and deep scaffolding.

We called our initial characterisation of scaffolding ‘neutral’ to signal that it doesn’t *require* that scaffolding be beneficial to the agent engaged in the task. That scaffolding does some good generally goes without saying. As noted above, the critical point that it shouldn’t go without saying has been made by, among others, Aagaard (2020) in his diagnosis of ‘dogma of harmony’, and by Slaby (2016) in his highlighting the dominance of a ‘user/resource model’ in 4E cognition. Like them we think that the presumption of helpfulness, where it remains, should be replaced by recognition of a substantial empirical question. To mark this, and prepare the way for our exploration of harmful and exploitative scaffolding, we propose that *Benign Cognitive Scaffolding* is external structure that changes the cognitive demands of a task in ways that serve the interests of the agent attempting the task. (The deep-shallow distinction is independent of the identification of scaffolding as benign, or — as we’ll see shortly — harmful and hostile.)

Scaffolding is benign when it serves the agent’s *actual* interests, which needn’t be appreciated by the agent. (Ants don’t need beliefs about food or their pheromone trails.) We can think about the agent’s interests narrowly in relation to the task, or broadly in relation to what is good for the agent. In the narrow, task-relative cases, the interests of the agent will be the success conditions of the task. If the jacket hanging from the bathroom door supports on-board memory and reduces sartorial mishaps, it is benign scaffolding for the task of remembering to dress smartly. This would be all we needed if agents only ever pursued one task at once, but they don’t. Sometimes, therefore, one and the same bit of external structure can be benign for some, but not other, tasks simultaneously attempted by an agent. A slide rule, for example, might augment my computational powers, while unpleasantly reminding me of a cruel mathematics teacher. If I’m trying to get a correct solution to a calculation that I can’t do in my head, the tool could be benign scaffolding for the calculating task. If my goal is to remain calm and optimistic, it might instead be harmful affective scaffolding. If I’m trying to do both at once, then the slide rule isn’t exclusively benign. We view it as an *advantage* of the task-relative criterion for benign scaffolding that we’ve offered that it can accommodate such cases by treating tasks and their success conditions separately. But mixed bag cases raise questions about whether the agent is benefitting overall, as do cases where an agent is attempting a harmful task like remembering to buy cigarettes.

Instead of focusing on task success conditions, then, we can consider whether an agent’s interests are being served by asking whether they benefit overall, that is whether the effect of the scaffolding is good for the agent. The local and global perspectives will coincide when the agent is attempting a task that straightforwardly serves their overall interests. We can distinguish these approaches without needing to settle disputes between competing accounts of overall interests, or to insist that scaffolding is only ‘really’ benign according to one of them. What matters, rather, is recognising that part of the burden of justification for claiming that scaffolding is benign involves defending a view about interests, whether narrow or broad, and accepting that this will sometimes be difficult. This can be so because of competing views about interests, and because some agents are themselves conflicted.

# 3. Hostile Scaffolding Characterised

We can now characterise hostile scaffolding: *Hostile Cognitive Scaffolding* is external structure that changes the cognitive demands of a task in ways that undermine the interests of the agent attempting the task, and in doing so serves those of another agent. At the start of the preceding section we quoted Clark saying that “exploitation of external structure is what I mean by the term *scaffolding*.” (Clark, 1997, p45). That’s a useful gloss of *benign* scaffolding. What we are proposing here is, roughly, that exploitation of one agent by another *by means of* external structure is hostile scaffolding. We emphasise that hostile scaffolding isn’t *merely* scaffolding that fails to be benign through inefficiency or unreliability, and so doesn’t serve, and may even undermine, the interests of the agent attempting a task. Consider a calendar that somehow encouraged inaccurate inferences about scheduling, or consumed more time and resources than it saved. Such a calendar would be harmful scaffolding to the time-management interests of the agent using it. There is more to being hostile than merely being harmful, though, because hostility is the expression of competing or antagonistic interests by other agents. In the following paragraphs we flesh out this picture.

We take the term hostile, as noted, from Sterelny (2003) who distinguished between informational environments as follows. In an *informationally transparent* environment, signals an organism can detect are reliably good occasions for behaviours it can produce, so cue-driven behaviour will be successful (Sterelny, 2003, p20)*.* Environments aren’t reliably transparent. When relevant features of the environment “map in complex, one to many ways onto the cues [an organism] can detect” they are *informationally translucent* (Sterelny, 2003, p21). Sometimes the translucency is not the result of indifferent heterogeneity in the world, but is produced by other living things with competing interests, such as the compelling begging calls of a parasitic cuckoo, in which case the environment is *informationally hostile*. That is, hostility is not merely a matter of antagonistic or competing interests existing, but concerns the expression of these interests through information. Hostility in this sense picks out a distinctive kind of antagonism and conflict, which we have selected as a target for thinking about ways in which scaffolding can be harmful. There’s no *a priori* reason to think that hostile scaffolding will also pick out something interesting, but in the following section we’ll offer case studies showing that it does.

Sterelny’s emphasis on hostility is, as we noted above, a corrective to over-optimistic slogans in artificial intelligence and robotics about letting the world be its own best model, or representation (Brooks, 1991; Clark 1997, p46). The world, Sterelny argues, can only be its best model when it is informationally transparent, and conflict will tend to make it less transparent. Control systems based on responding to cues depend on the reliability of the cues, but the predictable responsiveness of cue-bound agents is an opportunity for exploitation by manipulating the cues. Sterelny surveys examples including female *Photuris* fireflies that engage in aggressive mimicry by producing the mating signals of females of other firefly species in order to attract, kill and eat males of those species (Sterelny, 2003, p15). For a male firefly in the environment of a female *Photuris*, the world isn’t its own best model. Given his emphases on hostility and scaffolding, it might seem surprising that Sterelny doesn’t develop an account of hostile scaffolding. Rather, he has argued that harmful scaffolding is unlikely to be a serious problem because shared resources are made reliable by being shared, and the costs of exploiting by means of scaffolding are unlikely to be covered by the returns (Sterelny, 2010, p474f). We return to his reasons for scepticism, and respond to them, later.

Just as whether scaffolding is benign is relative to the task, agent and interests, so whether it is hostile is relative to the task and interests of one agent, and the interests of another. The user of the inefficient calendar we imagined above might be harmed, but that doesn’t make the calendar hostile. Hostile scaffolding, if there is any, has both victims and beneficiaries. A worry arises here. If the interests of one agent are being harmed, the chances are that one or more other agents will benefit *somehow*. If a calendar sometimes makes its user a little late, then others are likely to gain, even if by being a little closer to the front of the queue at the coffee shop than they would have been otherwise. This seems to satisfy our criteria for hostile scaffolding, suggesting that there is going to be *too much* hostile scaffolding, much of it involving indirect or happenstance gains to agents that aren’t involved. Dawkins faced a similar issue with his notion of an extended phenotype, considered as the downstream effects of a gene in an environment, that may extend beyond the body of the host organism. His approach to distinguishing genuine cases of extended phenotypes from mere downstream effects was to require that there be a chain of causal consequences that looped back to make a difference to the copying of the gene (Dawkins, 1982, p233f). An analogous move will help here: the agent benefitting must contribute to the placing of, or manipulate relevant features of, the structure that is a candidate for hostile scaffolding. So, if one rival had recommended or gifted the time-management tool intending for it to be counter-productive,[[2]](#footnote-2) we’d have a case of hostile scaffolding for *that* rival, and mere windfall gains for other, indirect beneficiaries.

Imagine a loyalty card from a food vendor where for every ten sandwiches you buy you get one free, and your progress is recorded by a series of stamps on the card. The card turns your history of purchases into a kind of asset. It scaffolds remembering that the sandwich vendor is an option, and how close you are to a free sandwich, and so can influence the relative attractiveness of other options. On some days you might choose a sandwich over, say, a pizza slice despite the sandwich queue being a bit long, and feeling more like pizza at the time. Hostility doesn’t have to be all or nothing, and most of your purchases can be deals that benefit both you and the vendor. But when the way the card scaffolds the lunch selection task leads you to waste time you don’t need to, or forego what you’d rather be tasting, you’re paying a price that benefits the sandwich vendor. That’s hostile scaffolding at the margins. Handing out loyalty cards is not an act of charity, but a bet that things like that *will* happen often enough that increased sales more than pay for the free sandwiches and the cards.

We earlier distinguished between shallow and deep scaffolding, where the latter involved significant processing happening outside the skin. This allows us to distinguish a weaker from a more restricted and stronger version of the claim that there can be hostile scaffolding. The weaker version concerns shallow scaffolding. Cases where the activity of an organism modifies its own environment to support behaviour selection, as some insects do with pheromone trails, count as benign scaffolding or cognitive niche-construction. Examples of manipulation where other organisms produce relevantly similar cues in ways that bias activity to serve the interests of the manipulators would then count as hostile scaffolding. Both cases transform the cognitive environment and influence activity but differ in whose interests are served. At least among non-human animals, the manipulation by cues we’d call shallow hostile scaffolding is amply covered by existing accounts of aggressive mimicry, cryptic colouration and other phenomena, including in Sterelny’s (2003) account of the threats of hostility to cue-bound behaviour, and by Dawkins’ own treatment of manipulation by cues (1982). The stronger, and more interesting because novel, claim is that *deep hostile scaffolding* is possible, which is to say manipulation and exploitation by means of external structure that carries some significant processing load (like slide rules and navigation maps). The following section provides some real examples of this.

# 4. Deep Hostile Scaffolding in the Wild

Suppose that you made a living from raiding ships that ran aground in a particular place. One way to increase the chances of them running aground would be to bring it about that the ships had navigation maps which worked well enough for everything else, but which incorrectly showed un-obstructed lines of constant bearing near your rocky shallows. The operations of drawing a straight line on such a map would normally be reliable transformations of a complex navigation task, but occasionally and non-accidentally misleading. Such maps would be deep scaffolding (tools for significantly distributed cognition) that was benign for most navigation tasks, and hostile, perhaps lethally so, for a select few. Whereever there is scaffolding, we suggest, there is the *possibility* of hostility, whether or not means to express it have been found, or whether the returns cover the costs. We have found particularly striking examples of deep hostile scaffolding in gambling technology. Casinos and gambling machine designers work to prolong gambling episodes, and to shorten the intervals between them. Some of the tools deployed to this end involve ambience, layout, and controlling lighting and sound to remove cues of the passage of time. A leading handbook of casino management favours thinking of casinos as mazes (Friedman, 2000).

The interests of casinos, which are businesses, are in making money, and contemporary machine gambling clearly serves their interests. With the increasing sophistication of the machines themselves, machine gambling has sharply risen in the fraction of casino revenue it contributes, the fraction of casino space allocated to it, and the number of machines (Schüll, 2012, p4-6). The gambling customer, on the other hand, might be pursuing multiple goals, including recreation, and cannot safely be presumed to have the goal of winning money overall. Up to a point, for some customers, the lost money is the acceptable price of the entertaining activity. The self-reports of regular Las Vegas machine gamblers show that many seek a state of comprehensive absorption in play that they call ‘the zone’ (Schüll, 2012). Contemporary gambling machines have features that enable regular gamblers to succeed in their self-identified task of entering a state of absorbed engagement, and the machines have consequently been recognised as examples of affective scaffolding (Colombetti and Krueger, 2015). Because casinos and machines are very effective at helping players get into the zone, they provide benign scaffolding for that task.

That casinos and machines can be benign *for some tasks* isn’t the end of the matter. Players have budgets in money and time and incur opportunity costs for exceeding them. Any player faces the narrow task of determining whether to continue wagering, whether the question is settled deliberately or by pre-reflective or implicit appraisal. The decision whether to not to continue is a point where the interests of player and house can come apart, because the player who stops gambling stops losing to the house precisely when they prioritise *anything else* they want to do with their money and time over continuing to play. The fact of budget limits gives us a criterion relative to which the interests of players can be served or subverted.

Affective or motivational scaffolding that is unreliably benign isn’t difficult to find. ‘Smart’ devices that track activity or proxies for stress level, for example, *could* contribute to beneficial improvement in someone’s self-care. When these tools involve significant external processing fed back to the user in simplified form, they can count as deep scaffolding, and can have downstream effects on behaviour, leading users to move around, take breaks, and so forth. One reason to doubt that such gadgets are *reliably* benign is provided by Nguyen’s argument that technologies that ‘gamify’ life have distorting effects on the agency of users seduced by the simplicity of numerical feedback into neglect of the more demanding and less certain practical reasoning that rational agency requires (Nguyen, 2020, Chapter 9). If he’s right, some smart devices could be harmful scaffolding, but that falls short of making them hostile as long as the harms were by-products without beneficiary. (The smart watch manufacturer needn’t gain directly from users responding to simplistic aggregations of their stress level or sleep quality.) The same tracking technology could become hostile if, hypothetically, used by an exploitative employer to increase the efficiency of value extraction in ways harmful to the interests of employees, who might respond to externally processed feedback about performance by refraining from taking breaks that would be good for them, or postponing using the bathroom.[[3]](#footnote-3)

Casino player tracking technology is a case of deep hostile scaffolding. The first tracking system in casinos was implemented in 1985 and mimicked ‘loyalty’ systems from airlines and banks (Schüll, 2012, p144). Players were given punch cards that were notched with every jackpot. After enough notches, cards could be redeemed for various rewards, providing an incentive to keep gambling and at the same time gathering data for casinos. Contemporary digital tracking is much more sophisticated, recording the time and value of every bet, a player’s win and lose rate, their pace of button pressing on machine games, the timing of breaks, and details of food and drink purchases. They aim to do this over a player’s entire history, perhaps in multiple venues (Schüll, 2012, Chapter 5).

These systems have become steadily more sophisticated and in 2005, Harrah formulated a plan to “optimize” player value with a system estimating, given historical data, how much a player could lose over how long while still continuing play. The system predicted a ‘pain point’ for the individual player, and dispatched a ‘Luck Ambassador’ to give out vouchers (for further gambling, meals, or show tickets) shortly before the pain point (Schüll, 2012, p154).[[4]](#footnote-4) Introducing a small ‘win’, even if not in the form of a cash payout, was supposed to defer the predicted cessation of play. That particular system backfired because players, especially the most valuable ones, didn’t like being interrupted (Schüll, 2012, p169f), but less obtrusive and disruptive interventions — including directly distributing non-cashable credits to the players at individual machines, and allowing refreshments to be ordered from the machines — have taken their place. The stated aim, and common effect, of most of these innovations is to prolong gambling sessions, and reduce the intervals between them. Revenue from gambling machines, which provide the most detailed player tracking data, is a function of ‘time on device’ and rate of play, which are what venues and designers seek to maximise. Multiline machines, for example, offer frequent small ‘wins’ (many of them net losses when all lines of plays are considered) in ways that encourage prolonged play (Dixon et al., 2014). Some machines adapt to ongoing player activity, for example disabling animations or other features when players play fast enough, to conform to a revealed preference for rapid interaction (Schüll, 2012, p168-9).

Player tracking systems coupled with attempts to predict the cessation of play, and postpone it, with interventions that cost the house less than it expects to extract, are exemplary cases of deep hostile scaffolding. It is scaffolding because the influence on player behaviour is facilitated through external structures that transform task demands. It is deep in the sense that casinos are gathering and processing historical and real-time player data to estimate the affective and motivational states of players and manipulate upcoming events (such as those shortly before the predicted ‘pain point’) so as to prolong play. It is hostile because the main goal is extracting more money beyond the limits set by the player’s own interests.

The hostile scaffolding in gambling environments goes beyond player tracking and ambience engineering. It includes fundamental architectural features of gambling machines. We show this by reference to selected features of slot machines, leaving aside poker-based and other games. The earliest slot machines were mechanical. Several adjacent spinning cylindrical reels with visible symbols at intervals, and a number of stopping points for each reel, were set up so that they would pay out under certain conditions. The 1899 ‘Liberty Bell’, for example, had three reels each with five symbols, and one stopping point at and between each symbol. The reels were set in motion by a player pulling a handle, and a braking system and timing bar made each reel stop individually. The machine accepted and paid out in nickels – one coin to play, ten dispensed when all three reels stopped on bells. The small number of possible outcomes meant that payouts had to be modest if machines were to be profitable (Schüll, 2012, p80).

Mechanical slot machines like this had *some* benign scaffolding-like features. The number of symbols on the reels and their spacing and motion could be observed through the viewing window, and reliably related – in fair machines, with repeated observation – to the actual odds. Apparent near misses, for example where only one reel was one stop away from a payout configuration, were reliable learning signals. Later electronic gambling machines broke the connection between the visible reels and the now less favourable odds, and caused apparent near-misses to multiply, even as the actual chances of winning fell. One key innovation was using electronic random number generators to determine the outcome of play. This gave designers and owners more precise control over the odds than mechanical systems, a change partly sold as a way of blocking tampering. After the introduction of random number generators, the visible spinning was no longer the process that culminated with the outcome of play, instead it was an animation reverse-engineered to present the already processed output of the random number generator.

This separation enabled the innovation called ‘virtual reel mapping’ (Schüll, 2012, p81f; Enkvist, 2009, p166f; Telnaes, 1984). This brings it about that the odds of winning are different from, and can be considerably *lower* than, what the appearance of the reels suggests. Lower actual odds enable larger, more tempting jackpots to be offered while keeping machines profitable. It was trivial to make the actual odds low by having the random number generator select an outcome from as large a range as the machine designer or casino wanted. Virtual reel mapping was a solution to the problem of relating the output of the random number generator to the activity of the animated reels, without changing the appearance of the reels. The key is that the randomization process, over a larger set of outcomes than is actually displayed, is ‘mapped’ onto the reels in a biased way, with disproportionately more of the virtual stops mapped onto “low-paying or non-paying blank positions” on the visible reel (Schüll, 2012, p87). The larger the number of non-paying stops, the more non-paying combinations, and the larger the jackpot that could be offered on a still profitable machine.

The intent to separate the activity of the visible reels from the actual odds is explicit in the patent, which explains that “the purpose of this invention [is] to increase the capability of the designer to include high payoffs without increased physical size of the machine and with uniform presentation of the games of different models to the player” (Telnaes, 1984, p8). It was possible to lengthen the odds with an ‘honest’ display by having more or larger reels. But players *correctly* perceive such machines “as being less “good” in terms of winning and payout chances” (Telnaes, 1984, p8). So, said Telnaes, “it is important to make a machine that is perceived to present *greater chances of payoff that it actually has* within the legal limitations that games of chance must operate” (1984, p8, emphasis added). The movement of apparently rigid cylinders with regularly spaced symbols encourage perceptual and other inferences or provide biased inputs for learning about chances. Both contribute to what the patent calls player ‘acceptance’, which we suggest is no more or less than relating to the machine as though the benign scaffolding features of mechanical machines are in place. What players are encouraged to ‘accept’ by the appearance and behaviour of the machine, though, is considerably more skewed against their interests in expected money than it seems.

We noted above that on a fair mechanical machine, apparent near misses are genuine. Near misses are also motivating, a point suggested in Skinner (1953, p397), leading to extended machine playing time (Strickland & Grote, 1967, Reid, 1986, Clark et al., 2009) and may be distinctively motivating for disordered gamblers (Sescousse et al., 2016). One of the earliest innovations in mechanical slots was expanding the viewing window vertically, allowing more genuine near misses to be seen (Schüll, 2012, p80). When the reel mapping and display are under designer control apparent near misses can be made more frequent. This requires stopping the reels so that the final configuration looks as though a small difference – at minimum a single reel stopping one step earlier or later – would have been a winning outcome. One Nevada industry dispute centred on this, because a line of machines which presented apparent near-misses several times more often than chance, by yet another patented method, were gaining market share from competitors (Harrigan, 2008, Enkvist, 2009).[[5]](#footnote-5) The outcome of that dispute imposed some limits on near-miss fabrication, but did not prohibit it. In fact, misleadingly frequent apparent near-misses are an inevitable by-product of virtual reel mapping. This is because the grouping of several non-paying virtual stops either side of a winning symbol will routinely make that symbol appear to stop ‘one stop away’ from a winning position more frequently, even though that single symbol corresponds to a larger set of non-paying outcomes (Harrigan, 2008). The ‘legal limitations’ that Telnaes referred to in the virtual reel mapping patent permit plenty of deception and manipulation. The deception here, too, is deeply scaffolded – the apparent activity of rigid spinning cylinders encourages stopping configurations to be treated as learning signals. But the signals are no more accurate than some of the lines of constant bearing on the malicious navigation map we imagined at the start of this section. The cognitive demands of the task of assessing the prospects of success from further play are transformed, biasing performance towards incorrect judgements that favour the house over the player. This has worked very well for the industry because, as noted above, machine gambling has come to dominate casino revues and space allocation. At the same time machine gambling addiction become more common and come to account for most cases of gambling addiction, with the onset of addiction in cases of machine gambling being dramatically quicker than for other forms of gaming (Schüll, 2012, p14-21).

A good question is why this has worked so well, given that prolonged play is also an opportunity to learn from experience of losing to the house. It is one thing to present a misleading appearance, another to maintain ongoing voluntary engagement in the very setting where players on average steadily lose more money than they budgeted. Various authors have, furthermore, emphasised ways in which (benign) scaffolding requires trust, which is sensitive to reliability (Sterelny, 2010; Coninx & Stephan, 2021). So how can hostile scaffolding continue to work, as it sometimes does? One part of the answer to this question, in some machines, is the extent of investment in encouraging trust in the misleading scaffolding features. Slot machine manufacturers have worked hard on cultivating the sense of interaction with a genuine physical apparatus. The company Bally once held a leading position because their machines’ handles could be pulled more or less quickly, with apparent haptic feedback about the progressive loading of reel springs (Schüll, 2012, p83; Enkvist, 2009, p164f). The virtual reel mapping technology posed challenges for the sense of interaction because it broke that link, and companies explored different ways of *simulating* convincing mechanical interaction without giving players any genuine control. Ekvist quotes a registered patent that referred to the “certain amount of feel and *presumed control* over the device” (2009, p165, emphasis added). Handles were eventually found to slow down play unacceptably, and were displaced by button-push controls. Another innovation allowed players to stop the animated reel spinning. Although this made no difference to the outcome, “gamblers using such “stop” features seem to feel they have an effect on outcomes and […] to persist at play for significantly longer periods” (Schüll, 2012, p84). Complementary to this, manufacturers worked to make the animated spinning reels look like physical objects even when they were simulated or controlled by stop motors. One solution was to layer semi-transparent computer graphics over genuine but blank spinning reels, another to stack liquid crystal displays to enhance the appearance of depth (Schüll, 2012, p83). In both cases insufficiently convincing two-dimensional animations were augmented to make the display look more like the rigid spinning reels on mechanical machines, encouraging players to engage as though interacting with an older mechanical slot machine.

Another part of the answer is that some of the feedback, including apparent near misses, itself consists of *misleading* learning signals, some of them very salient and reinforcing, that will be in competition with the signals provided by the larger pattern of losing money over time. That larger pattern is, furthermore, obscured by a scattering of small wins. Ross (2020) provides a further analysis of properties of the learning environment provided by machine gambling. He begins by drawing a useful contrast between non-human mammal and human encounters with targets of substance addiction. Elephants and baboons can and do get drunk when they find low-toxicity sources of alcohol, such as fermented fruit, but “they are at no risk of addiction […] because they cannot cultivate sources of low-toxicity alcohol. Their parties are windfalls, the frequency of which they cannot influence” (Ross, 2020, p. 6). Technological innovation has enabled humans, Ross contends, to ‘engineer addictive environments’, including by processing and stockpiling alcohol, nicotine and other substances, and by building environments, including casinos, that foster addiction. As Ross points out, part of how this works in the machine gambling case is because our reward learning systems find the cycling of action and feedback offered by gambling highly reinforcing, but are unable to ‘settle on a model of genuine randomness’ (Ross, 2020, p. 3). He argues that it’s not reasonable to say that there is anything *wrong* with mammalian learning systems, including those of gambling addicts, given that evolutionary history did not require them to cope with anything like electronic gambling machines. Rather, we should recognise the role of exploitative environments, including the exploitative learning environments that are the ‘business model’ (Ross 2020, p. 7) of casinos, in explaining addiction. Our additional point is to show how some of these exploitative environments contain deep hostile scaffolding.

The points we have made about hostility are not affected by the fact that most users of slot machines play voluntarily, and that the activity is presented and often understood as a form of entertainment. Hostility need not be an all or nothing affair, and is relative to a task and the interests of two agents. The customer who enters the casino for fun, willing spend some time and lose some money while having it, still faces the periodic task of determining whether they have had enough yet. This might be more or less explicit: some gamblers might go in having reflectively identified a budget for the session in money or time, but even a gambler who hasn’t done so will have goals like paying their bills or showing up for work, that sooner or later will come to be at stake. The narrow task of deciding whether or not to continue gambling can be attributed to any gambler, and the house gains whenever the answer is to continue. Scaffolding that tends to pull players beyond their budget points is hostile by this standard.

What about the overall interests of gambling customers? These will vary because gamblers are not homogenous, and sometimes individual gamblers might be conflicted about what they want. Whether someone’s gambling is harming them won’t be independent of what they can afford, and the opportunity cost of time spent gambling won’t be independent of facts about their wider situation. Considering the overall picture instead of the individual session still involves determining whether a person is pursuing recreation they can afford (in money and time) or losing more than they gain. This losing can include harm against long term or standing goals, by defeating their financial plans or damaging valued relationships. In those cases we can refer to *those* standing goals to specify overall interests that the players would recognise, which are undermined by prolonged play in ways that serve the interests of the house. This will sometimes be uncontroversial: the gambler whose excessive truancy leads to losing their job or family is harmed overall. People who voluntarily present for pathological gambling treatment are saying as much themselves. If hostile scaffolding makes a contributing difference to their pattern of behaviour, it is hostile to their overall interests, by turning recreation into possibly ruinous exploitation.

## 5. An objection

We noted above that Sterelny, although sensitive to the importance of both scaffolding and hostility, has said that he doesn’t think manipulation of public epistemic resources is likely. He does say that “hostile manipulation of [our] informational environment is a serious danger”, but sees the danger as restricted it to a limited set of interactions. These mostly comprise “one-on-one high-stakes negotiations” (Sterelny, 2010, p474), such as someone exploiting or harming the notebook-using Otto from Clark and Chalmers (1998) by erasing or altering Otto’s external memory. These are, as he notes, the kinds of interaction that are salient if you favour a Machiavellian model of social interaction. But for Sterelny, manipulation involving public resources (such as deceptively changing the maps in a subway station) is unlikely *because* sharing itself increases reliability, and the fact that many agents use different copies of the resources at unpredictable times makes it difficult to exploit a chosen target. Shared epistemic niches, that is, are armoured against some Machiavellian moves. “In many circumstances, public domain resources cannot safely be used to manipulate a specific target for a specific purpose” (Sterelny, 2010, p474). We’ll take these remarks as an objection, giving reasons to think that hostile scaffolding isn’t *likely*.

Sterelny is of course correct that much scaffolding is public, and that public scaffolding is often characterised by considerable redundancy. One of his examples is maps of underground train systems, which are duplicated in stations, train carriages and printed media. Those resources scaffold the environment of people faced with the task of planning travel and it would take substantial effort and cost to manipulate such systems in order to misdirect a single passenger, who has many maps to choose from. Interfering with train maps is, he says, consequently unlikely to bring sufficient returns. He also refers to the Monty Python sketch in which someone mischievously produces a Hungarian-English phrasebook leading users to make inappropriate and ridiculous utterances (‘My hovercraft is full of eels’), and suggests that some of the humour here arises because “it is difficult to envisage circumstances in which an author would gain from producing a maliciously misleading phrasebook, for an author cannot know when, where, by whom or with what effect such a book will be read” (Sterelny, 2010, p275). Here, too, Sterelny is correct: Even if an environmental intervention by one agent will mislead another agent who happens to rely on it, that doesn’t ensure that the perpetrator will benefit.

The considerations that Sterelny emphasises here aren’t, however, fully general. They limit the reach of hostile scaffolding, but do not exclude it entirely. In the imagined malicious navigation map case at the start of this section, for example, it might only be necessary to replace a single chart to influence a ship’s course. In the case of affective scaffolding in casinos, a key part of the story is that the casino itself has extraordinarily comprehensive control over the whole environment, including its layout and design, and what opportunities for various kinds of activities are to be found within it. Casino operators have conducted extensive research on ambience and spatial arrangements (Schüll, 2012), and the player-tracking tools that seek to extend ‘time on device’ monitor players in high resolution within these highly controlled environments. Players enjoy none of the protections of redundancy, but must muddle along in a hostile niche. The casino’s target isn’t a specific individual that needs to be picked out of a crowd but anyone and everyone who enters, *and* they have the capacity to track individuals in detail within their venues. The same goes for some other retail spaces and, as Slaby (2016) notes some workplaces. Not only that, achieving similar levels of control over an environment doesn’t require command over a large physical space, as with casino-managers, because an increasing number of the relevant environments people face today are *virtual*, and the control has only to be achieved within a social media app or computer game. The potential victims of a variety of forms of exploitation carry increasingly powerful and permanently connected computing devices around with them in the form of their mobile phones. So unlike the deceptive train map scenario Sterelny imagines, the targets broadcast their location and behaviour, and carry the instruments of their possible bespoke exploitation around with them. In many of these digital environments the very tools to optimise time on device developed in gambling have been deployed or modified, leading Harris, former Google design ethicist, to call a smartphone ‘The Slot Machine in Your Pocket’ (Harris, 2016). That users often don’t directly pay in money is a dis-analogy with the casino case, but is irrelevant to the hostility, because much connected media and many ‘free’ games extract advertising revenue that is a function of time on device. People on social media applications pay opportunity costs for their time and also have to determine when to stop, and when to resume. In both cases their interests and those of providers can come apart. The malicious phrasebook prank is ‘ballistic’ in character, its imagined perpetrator isolated from the consequences for victims. Casino know who they are manipulating, as do social media and search companies who also know much of their users’ individual history, and what devices they are holding. To state the point here more generally, hostile scaffolding will pay its way when there are ways of placing it around potential targets, and the costs are more than covered by the returns. The considerations that fix the boundaries between profitable and unprofitable scaffolding, and the challenges of matching scaffolding to targets, are not fixed, but vary with available technology. The increasingly powerful, cheap, ubiquitous and connected computing devices that are our mobile phones make the robustness and wide duplication of train maps small comfort indeed. Sterelny’s general warning to take hostility seriously stands, and optimism about scaffolding being reliably benign is in no better shape than optimism that the world is its own best model.

# 6. Conclusion

Clark, who greatly raised the profile of scaffolding, once wrote that the “single most important task, it seems to me, is to better understand the range and variety of types of cognitive scaffolding, and the different ways in which non-biological scaffoldings can augment (or impair) performance on a task” (Clark, 2002, p29). The parenthetical ‘or impair’ is a rare interruption to his usually optimistic focus on benign scaffolding, and is repeated in the same paragraph when he says that the “Holy Grail here is a taxonomy of different types of external prop, and a systematic understanding of how they help (and hinder) human performance” (Clark, 2002, p29; Clark, 2010, p58f). We take our treatment of hostile scaffolding to be a contribution to the task Clark highlighted, focused on his passing hints about unhelpful scaffolding, and significantly inspired by Sterelny’s (2003) working out of the importance of informational hostility. The notion of hostility provides a demanding target, requiring both an implicated beneficiary and a loser from the interaction with the scaffolding.

We observed near the start of this paper that our claims are not entirely unprecedented, and we close by noting some complementarities and differences with a selection of valuable recent work. First, as noted, we share Aagaard’s (2020) observations about ‘dogma of harmony’ in thinking about 4E cognition. Our argument that hostile scaffolding is possible, and real, can be seen as a special case of his recommendation that whether 4E phenomena are beneficial be regarded as empirical, and open for exploration, and complements his approach which makes only passing mention of scaffolding.

Liao and Huebner (2021) have argued persuasively that there are ‘oppressive things’, that is material artefacts and environments which contribute to oppression, when their effects are biased in the same direction as, and they are causally embedded in, an oppressive system. Liao and Huebner endorse two of the four components of 4E cognition – that cognition is *embedded*, and *embodied* – say that they are ‘sympathetic’ to a third – that it is *enactive* – but say that neither of them is ‘particularly committed’ to the fourth – that cognition is *extended* (2021, n3). This isn’t necessarily a rejection of the possibility of deep scaffolding, because they’re only distancing themselves from ‘first wave’ extended mind thinking (see Sutton 2010), but that is our main focus. Their concern with oppression, understood as a relationship between groups, is different from our understanding of hostility which relates to individual agents. Liao and Huebner consequently don’t count an imagined biased slot machine as oppressive because it would harm ‘all players equally’ (2020, p8), although they are also aware that the organisation of gambling industries exploits and maintains oppressive class relations. Our respective accounts therefore sometimes pick out different examples, with hostile scaffolding including environmental structure that exploits individuals indifferently to their group membership. But they may also complement each other. Indeed, they jointly suggest the possibility of oppressive scaffolding, which we cannot begin to explore here.

Slaby’s (2016) account of ‘mind invasion’ is a further partial precedent. He argues that affective scaffolding in some environments, especially workplaces, can amount to a kind of ‘mind invasion’ when it sculpts behaviour and norms in ways that are detrimental to the interests of employees. Slaby criticises much thinking about extended cognition (and extended minds) for taking for granted a ‘user/resource model’ which presumes that external structure will serve the interests of the agents encountering it. Like Liao and Huebner, Slaby’s intention is partly political. Again, this means that ‘mind invasion’ and hostile scaffolding may pick out different examples, with the latter including cases of individual exploitation beyond workplaces. Finally, Slaby’s account focuses on affective scaffolding that we’d count as shallow, even if its accumulated downstream effects can be substantial. So as well as picking out different examples, the case we’ve developed there covers different ground in considering scaffolding that is cognitively hostile, as well as deep in the sense of doing significant cognitive work.

In closing, while the literature on situated and extended cognition is dominated by examples of cognitive scaffolding that are *benign,* in changing the cognitive demands of a task in ways that favour the agent performing the task, we should not assume that this is generally true. We’ve argued that scaffolding can also be *hostile*, in serving the interests of another agent. The notion of deep hostile scaffolding points to a distinctive and largely neglected route to behaviour manipulation and exploitation, through the external loops of distributed or extended cognition. We’ve provided extended examples from casinos and some types of electronic gambling machines to argues that there are genuine examples of deep hostile scaffolding. If we’re right, further work is called for, including work estimating how much hostile scaffolding there is, who is gaining and losing, what varied forms it takes, and what defences we may have or be able to develop, and whether or how it might be advisable to regulate technology that exploits or manipulates people in these ways. Humans are generally regarded as distinctive in the extent and variety of their reliance on cognitive scaffolding (Clark, 1997; Sterelny, 2012). If that is correct, then the costs of presuming the ‘dogma of harmony’ could be very high for us, and hostile scaffolding is something to take seriously.

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1. Sterelny (2010) drew attention to an incomplete list of significant dimensions along which scaffolding can vary, and Saarinen (2020) provides a helpful review of dimensions along which specifically affective scaffolding has been regarded to differ, arguing that a permissive and broad approach will be more productive than strict criteria. Coninx and Stephan (2021, pp 44-5) note in connection with affective scaffolding that a risk of more demanding criteria is to neglect potentially interesting phenomena. [↑](#footnote-ref-1)
2. We emphasise that it isn’t the intending that is doing the work here, but playing a role in the scaffolding being where it is, like it is. [↑](#footnote-ref-2)
3. Slaby (2016) argues for something along these lines, although he focuses on the downstream exploitative effects, in enculturation and habit formation, of what we would call shallow (affective) hostile scaffolding. [↑](#footnote-ref-3)
4. The design of this system was plausibly motivated by the ‘peak end rule’ suggesting that both experienced and remembered utility (or pain) are disproportionately sensitive to the evaluation of the most extreme point, and the final stage, of an experience rather than duration or total (Kahneman et al., 1993). [↑](#footnote-ref-4)
5. Universal Distributors patented a system which generated high numbers of apparent near misses, and received regulatory approval for it. “Universal’s “near-miss” software increased the excitement during play and extended the average length of each gambling session, therefore resulting in a higher player appeal” (Enkvist, 2009, p174; Okada, 1986). [↑](#footnote-ref-5)