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Effect of snack-food proximity on intake in general population samples with higher and lower cognitive resource

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ABSTRACT

Objective: Placing snack-food further away from people consistently decreases its consumption ("proximity effect"). However, given diet-related health inequalities, it is important to know whether interventions that alter food proximity have potential to change behaviour regardless of cognitive resource (capacity for self-control). This is often lower in those in lower socio-economic positions, who also tend to have less healthy diet-related behaviours. Study 1 aims to replicate the proximity effect in a general population sample and estimate whether trait-level cognitive resource moderates the effect. In a stronger test, Study 2 investigates whether the effect is similar regardless of manipulated state-level cognitive resource.
Method: Participants were recruited into two laboratory studies (Study 1: $n = 159$; Study 2: $n = 246$). A bowl of an unhealthy snack was positioned near (20 cm) or far (70 cm) from the participant, as randomised. In Study 2, participants were further randomised to a cognitive load intervention. The pre-specified primary outcome was the proportion of participants taking any of the snack.
Results: Significantly fewer participants took the snack when far compared with near in Study 2 (57.7% vs 70.7%, $\beta = -1.63$, $p = 0.020$), but not in Study 1 (53.8% vs 63.3%, $X^2 = 1.12$, $p = 0.289$). Removing participants who moved the bowl (i.e. who did not adhere to protocol), increased the effect-sizes: Study 1: 39.3% vs 63.9%, $X^2 = 6.43$, $p = 0.011$; Study 2: 56.0% vs 73.9%, $\beta = -2.46$, $p = 0.003$. Effects were not moderated by cognitive resource.
Conclusions: These studies provide the most robust evidence to date that placing food further away reduces likelihood of consumption in general population samples, an effect unlikely to be moderated by cognitive resource. This indicates potential for interventions altering food proximity to contribute to addressing health inequalities, but requires testing in real-world settings.
Trial registration: Both studies were registered with ISRCTN (Study 1 reference no.: ISRCTN46995850, Study 2 reference no.: ISRCTN14239872).

1. Introduction

Populations of lower, compared with higher, socio-economic position (SEP) consume more energy-dense foods (Monsivais & Drewnowski, 2009) and fewer fruits and vegetables (Stringhini et al., 2011), a suboptimal diet contributing to poor health at population level (Newton et al., 2015). Specifically concerning education level, being one indicator of SEP, those with lower, compared with higher, education levels consume less fruits and vegetables, more red and processed meats and more sugar (Maguire & Monsivais, 2015). These findings highlight the need for effective interventions to improve diet in these groups. Of concern is evidence that interventions that rely on providing information to change behaviour are more likely to benefit those of higher SEP, i.e. those with higher education, income and occupational levels (Beauchamp, Backholer, Magliano, & Peeters, 2014; Lorenc,

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Petticrew, Welch, & Tugwell, 2013; McGill et al., 2015), exacerbating observed inequalities in health. Conversely, interventions that alter structural cues in the environment, thought to operate largely outside of awareness, have potential to reduce health inequalities (Hollands, Marteau, & Fletcher, 2016; Marteau, Hollands, & Fletcher, 2012).

One factor that may moderate outcomes of information-based interventions is cognitive resource, a term encompassing mental processes including intelligence and executive functions (EF), the latter of which is involved in planning and regulating thoughts and behaviour (Diamond, 2013). Indicators of lower SEP such as greater financial strain and lower maternal education level during early years of development and over the life course have a negative impact on trait-level cognitive resource (Raver, Blair, & Willoughby, 2013; Singh-Manoux, Richards, & Marmot, 2005) and associated brain structures (Noble et al., 2015). Sustained poverty throughout young adulthood predicts poorer cognitive function in midlife (Al Hazzouri, Elfassy, Sidney, Jacobs, & Yaffe, 2017). SEP negatively impacts state-level cognitive resource, with people from lower income groups showing poorer impulse control (Mani, Mullainathan, Shafir, & Zhao, 2013) and greater vulnerability to unhealthy food advertising when under temporary cognitive load (Zimmerman & Shimoga, 2014). Lower cognitive resource, such as EF, is associated with overeating and higher BMI in young people (Groppe & Elsner, 2015; Reinert, Po'e, & Barkin, 2013) and lower quality food choice in adulthood (Cohen, Yates, Duong, & Convit, 2011; Hall, 2012). Despite this evidence, intervention studies rarely explore differential outcomes by SEP (McGill et al., 2015) or cognitive resource. Given the cognitive effort required to translate health information into sustained behaviour change, differences in cognitive resource by SEP could explain the evidence that information-based interventions may contribute to diet-related health inequalities. In contrast, if interventions that alter environmental cues do not rely on cognitive resource for their impact, they may be less likely to widen existing inequalities and may even reduce them if more effective in those with lower cognitive resource.

There are a variety of environmental cues that can be manipulated to shape diet-related behaviours (Hollands et al., 2013; Hollands, Bignardi, et al., 2017), such as the distance at which food is positioned. Increasing the distance between food and people decreases the likelihood that they select and consume it (for reviews see Bucher et al., 2016; Hollands, Carter, et al., 2017; see also Baskin et al., 2016; Kroese, Marchiori, & de Ridder, 2015; Musher-Eizenman et al., 2010; Meyers & Stunkard, 1980; Levitz, 1976) and this has been observed across a range of foods including chocolate, desserts, savoury snacks and sliced fruits and vegetables. This “proximity effect” seems consistent regardless of craving (Maas, de Ridder, de Vet, & de Wit, 2012) and food preferences (Privitera & Zuraikat, 2014) and occurs even when increases of distance are relatively small e.g. 25.4 cm (Rozin et al., 2011) or 50 cm (Maas et al., 2012). More distant snacks, that require people to reach for them, are rated as more effortful to obtain compared to closer snacks (Maas et al., 2012). Since the least effortful course to obtain food is considered the most likely, placing unhealthy foods further away should reduce their intake without relying on explicit instruction or conscious deliberation by the actor (Marteau et al., 2012). This means that, in theory, such an intervention should be similarly effective at changing dietary behaviour in populations with lower as well as higher cognitive resource.

Current evidence for whether the proximity effect is moderated by cognitive resource is limited. First, sample populations are not representative of general populations, with most studies recruiting primarily university staff and students (Maas et al., 2012; Meiselman, Hedderley, Staddon, Pierson, & Symonds, 1994; Painter, Wansink, & Hieggelke, 2002; Privitera & Creary, 2013; Privitera & Zuraikat, 2014; Rozin et al., 2011; Wansink, Painter, & Lee, 2006). These populations have higher education levels, indicating higher SEP, and thus likely have higher levels of cognitive resource. Second, the quality of existing studies is compromised by small sample sizes and absence of power calculations (e.g. Maas et al., 2012; Painter et al., 2002; Privitera & Creary, 2013; Privitera & Zuraikat, 2014; Wansink et al., 2006) which limit the reproducibility of the effects found in many studies (Munafó et al., 2017; Button et al., 2013). Studies recruiting larger samples in general populations will provide more reliable and generaliseable estimates of the magnitude of the proximity effect (Bucher et al., 2016). Furthermore, to improve the reproducibility of existing studies and ensure quality-control and transparency of future research, studies should be pre-registered and study protocols and related information made available to other researchers (Munafó et al., 2017; Button et al., 2013).

To date, the hypothesis that altering environmental cues shapes eating behaviour in all recipients, irrespective of cognitive resource, remains largely untested (Hall & Marteau, 2014). As far as we are aware, no studies have investigated whether the proximity effect is moderated by cognitive resource. Such an investigation may determine whether the proximity effect has potential to improve diet in lower as well as higher SEP groups. Ascertaining whether any effect is evident regardless of cognitive resource could inform efforts to develop interventions that avoid increasing existing inequalities in dietary behaviour at population level.

The current studies build on existing literature: first, by estimating the magnitude of the proximity effect in larger general population samples, including those with lower education level (as an indicator of SEP), by replicating and extending an existing study conducted in a smaller university student sample (Maas et al., 2012), and second, by providing preliminary evidence for whether the proximity effect is moderated by cognitive resource. In line with previous research (Maas et al., 2012), the studies also assess effort as a possible underlying mechanism of the proximity effect.

2. Study 1

2.1. Methods

Further details of the methods used for Study 1 can be found in the published study protocol (Hunter, Hollands, Couturier, & Marteau, 2016).

2.1.1. Hypotheses

1. A lower proportion of participants will take the snack food when it is placed far (70 cm) compared to when it is placed near (20 cm) to them.
2. The proximity effect will not be moderated by cognitive resource.

2.1.2. Study design and setting

Participants were randomly allocated to one of two conditions using a between-subjects experimental design:

1. Snack bowl is placed near (20 cm)
2. Snack bowl is placed far (70 cm)

Participants were tested individually in sessions running between 9am and 8pm in a multi-purpose room – see Fig. 1 for a map of the testing room.