Controlling food seeking in the presence of food cues. Commentary on van Steenbergen, Watson, Wiers, Hommel & de Wit, "Dissociable corticostriatal circuits underlie goal-directed versus cue-elicited habitual food seeking after satiation: Evidence from a multimodal study".

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Rates of obesity in the human population have reached epidemic proportion (WHO, 2015). It has been suggested that the abundance of available food is one factor underlying increasing rates of weight gain (Hill & Peters, 1998). The preponderance of food "cues", stimuli that elicit food seeking and consummation behaviour, in our obesogenic environment, however, might also be a vital contributor (Hill & Peters, 1998). For this reason, understanding the neural mechanisms driving human food-seeking behaviour is of vital importance.

in this edition of EJN, van Steenbergen et al. use a multimodal approach to provide a comprehensive investigation of human goal-directed and cue-driven food seeking. Behavioural results were in accordance with prior observations in animal (Adams, 1982) and human (Talmi et al., 2008) studies. Participants learned to associate two food outcomes with two responses (Instrumental training of R-O associations) and two visual cues (Pavlovian training of S-O associations). Feeding to satiation on one of the two items led to stimulus-specific devaluation. Given free choice, the devalued item was chosen less frequently than the non-devalued item. When one of the Pavlovian cues was present, however, choice was driven by the cue, even if that led to choice of the devalued food (Pavlovian-instrumental transfer). In accordance with dual-process models of behaviour (e.g. Balleine & O'Doherty, 2010), neuroimaging results suggested these were driven by independent neural circuits. Value-driven choice in the absence of cues was associated with activation in vento-medial prefrontal cortex (vmPFC). White matter tract strength between this region and a caudate seed positively correlated with individual goal-directed responding. No such correlation was observed for PIT index. Conversely, cue-driven responding was associated with activation in posterior putamen. Voxel-Based Morphometry (VBM) showed this form of responding positively correlated with grey matter density in premotor cortex, with no such correlation for value-driven responses. The distinct corticostriatal pathway governing goal-directed behaviour and putamen control of habitual responding were consistent with animal research (see Balleine & O'Doherty, 2010 for a comprehensive review). This study extends the understanding of human food seeking. It highlights the strength of taking a multimodal approach to the study of neural function. The authors propose goal-driven and cue-elicited food seeking are governed by independent circuits. In this case, converging structural data enable ruling out the alternative explanation of the functional data as independent regions of activation within a single circuit. This is particularly important is studies of this nature, where sample size, and consequently statistical power, is low. Indeed, more lenient statistical thresholds were required to observe some of the effects. This makes convergence of effects across analyses, as well as with prior research, even more crucial. As a neuroimaging community we must consider best practise for ensuring the integrity of our data. Whilst, of course, collecting appropriately large samples should be standard practise, multimodal approaches such as that taken by van Steenbergen and colleagues offers a promising approach to gain a comprehensive illustration of neural processes with greater confidence.

This brings us to the question of what drives our food-seeking behaviour in the real world, where food cues proliferate. If habit overrides goal-directed control, this may help to explain the mixed effectiveness of paradigms and interventions targeting goal-directed or self control systems (Walsh & Kiviniemi, 2014; Lebens et al., 2011). We have certainly observed habit can override all other factors in guiding food choice (Hensels & Baines, 2016). Results of studies such as these would suggest that optimal interventions in human food seeking must target habitual, not goal-directed, controllers.

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