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Behavioural inhibition and valuation of gain/loss are neurally distinct from approach/withdrawal

--Manuscript Draft--

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Abstract:	Gain or omission/termination of loss produce approach; while loss or omission/termination of gain produce withdrawal. Control of approach/withdrawal motivation is distinct from valuation of gain/loss and does not entail learning – making “reward” and “punishment” ambiguous. Approach-withdrawal goal conflict engages a neurally distinct Behavioural Inhibition System, which controls “anxiety” (conflict/passive avoidance), but not “fear” (withdrawal/active avoidance).

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03. AN INDEXABLE AND INFORMATIVE COMMENTARY TITLE

Behavioural inhibition and valuation of gain/loss are neurally distinct from approach/withdrawal
[11 words]

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10. 60-word ABSTRACT

Gain or omission/termination of loss produce approach; while loss or omission/termination of gain produce withdrawal. Control of approach/withdrawal *motivation* is distinct from *valuation* of gain/loss and does not entail learning – making "reward" and "punishment" ambiguous. Approach-withdrawal goal conflict engages a neurally distinct Behavioural Inhibition System, which controls "anxiety" (conflict/passive avoidance), but not "fear" (withdrawal/active avoidance). [55 out of 60 words max]

11. 1000-word MAIN TEXT (with paragraphs separated by full blank lines, NOT tab indents)

In Section III.1, De Dreu & Gross contrast reward seeking with loss aversion and conflate behavioural inhibition with fear and active avoidance. We argue that this confuses: (a) valuation with motivation; (b) anxiety with fear; and (c) reinforcers with reinforcement. Making these distinctions has consequences for their proposed neuropsychology.

The expectation/availability (innate or learned) of gain elicits approach. However, omission/termination of expected gain elicits defensive withdrawal (Adelman & Maatsch, 1956) and attack (Gallup, 1965; Kelly & Hake, 1970), as does an *explicit* aversive stimulus, such as shock (Renfrew & Hutchinson, 1983). Importantly, even in the presence of loss aversion (Kahneman & Tversky, 1979; Novemsky & Kahneman, 2005; Tversky & Kahneman, 1991), approach tendencies can be stronger than withdrawal (Hall, Chong, McNaughton, & Corr, 2011) – likely as a result of their different goal gradients (Brown, 1948). So, approach/withdrawal motivations are controlled independently of gain/loss valuations (Hall et al., 2011); and it is important to keep valuation and motivation theoretically separate (Corr & McNaughton, 2012) and always take into account the role of contingency (Figure 1).

----- Figure 1 about here -----

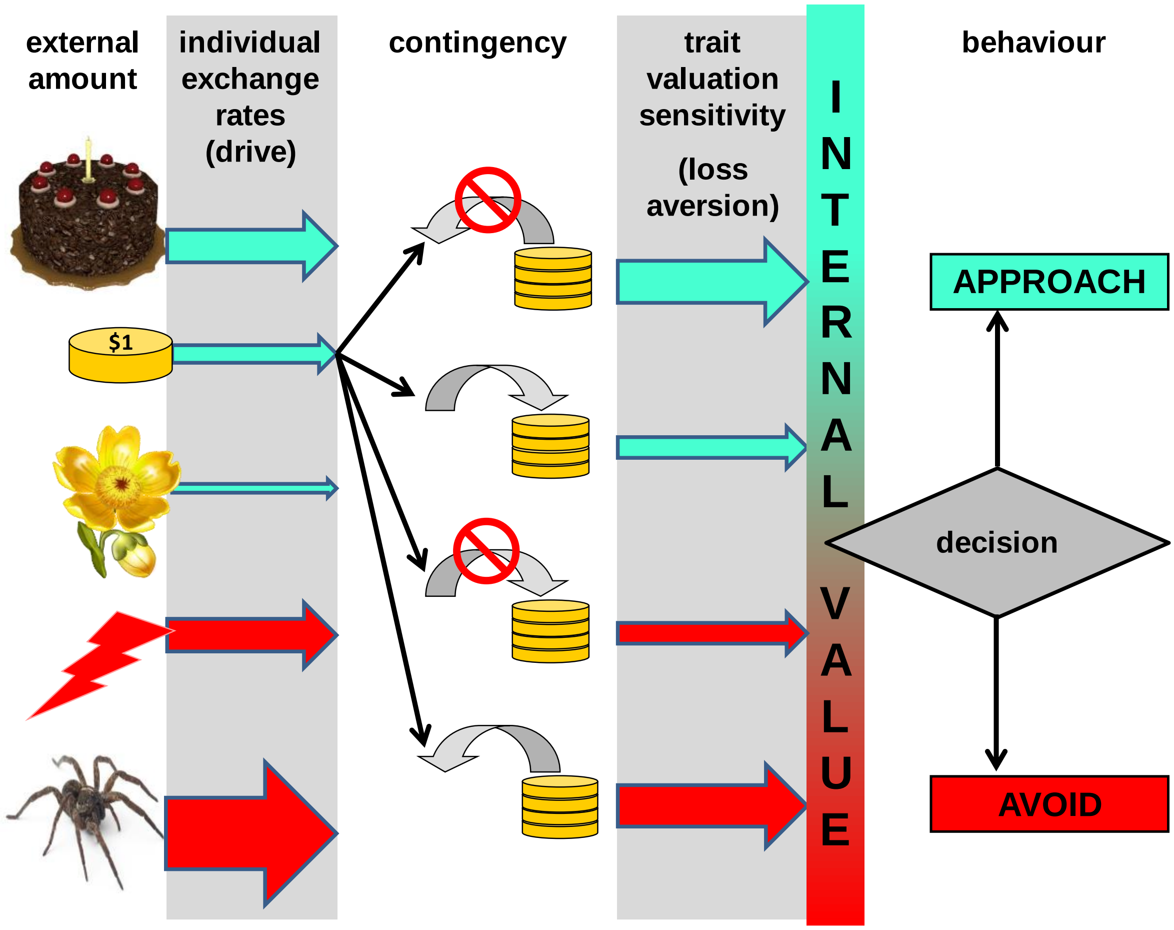

Figure 1. *Relations between external amount, contingency and value. An external item will have a specific amount (e.g., 1 entire cake) that, together with the current level of drive (which acts like a currency exchange rate) for that kind of item for that person, determines its primary internal value (thickness of arrows in first column). As shown for the case of $1, this interacts with whether the item will be gained or lost to determine the direction and size of its internal value as ultimately measured by the effect on behaviour. The direction of this effect is reversed if the [expected] gain or loss is omitted. Loss (removal from a store of items) is most easily controlled with money but will also occur when, for example, one rat steals the food from another rat. Figure and legend from McNaughton, DeYoung, and Corr (2016)*

It is also important to keep “anxiety” separate from “fear”. Despite their frequent semantic conflation (McNaughton, 2018), the neuropsychology and psychometric evidence is clear on their differences (Corr, DeYoung, & McNaughton, 2013). In contrast to a fear/withdrawal system which is sensitive to threat, the anxiolytic-sensitive Behavioural Inhibition System (Gray, 1977) processes goal-conflict and amplifies behavioural inhibition/passive avoidance/defensive quiescence, attention, arousal, and negative bias (Gray & McNaughton, 2000; McNaughton & Corr, 2004). This is neurally distinct from the panicolytic-sensitive systems that mediate fight, flight, freezing, and withdrawal/active avoidance (Figure 2), collectively known as the Fight-Flight-Freeze System (FFFS). Note that “fight” in this context is a defensive response and quite distinct as a behaviour from the predatory “attack” that is contrasted with “defense” in the target article – although in human personality questionnaire studies the relations between withdrawal, defensive attack, and predation are unclear (Corr, 2016). Contrary to the picture painted by De Dreu & Gross, it is anxiety rather than fear that is linked to the release of stress hormones like cortisol (see McNaughton, 1989, pp 57-59); and, while $5HT_{1A}$ agonists are anxiolytic but not panicolytic, the serotonin system as a whole innervates and affects not only the Behavioural Inhibition System but also the withdrawal and the approach systems, with quite high-level consequences (Carver, Johnson, & Joormann, 2008).

----- Figure 2 about here -----

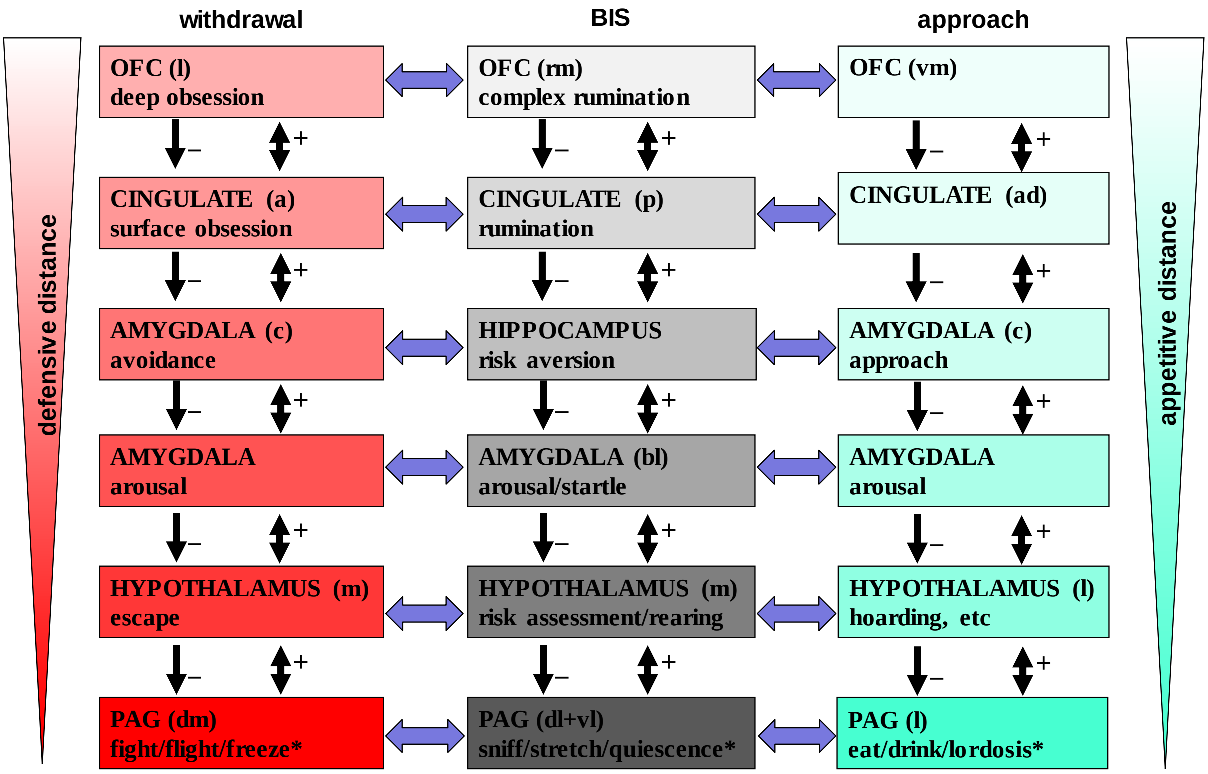

Figure 2. *Hierarchical organization of approach, withdrawal and behavioural inhibition (BIS) in terms of behaviour and neural level. Lower levels process small defensive distances; higher levels process greater ones (i.e., negative events that are more distant in space or time). Activation tends to spread through the whole system (double-headed black arrows) but strong activation of a higher level (e.g., avoidance) inhibits (single-headed arrows) the behavioural output from (but not the activation of) lower levels (e.g., escape). * = static postures that achieve withdrawal, conflict resolution, or approach, respectively. Abbreviations: PAG = periaqueductal grey; OFC = orbital frontal cortex. Figure and legend from McNaughton and Corr (2018)*

For the same reasons, we think their picture of prefrontal control networks should be split and extended to subcortex. We agree that anxiety involves the inferior frontal gyrus (Shadli, McIntosh, Glue, & McNaughton, 2015), basolateral amygdala, hippocampus, ventromedial orbital cortex (Figure 2), and insula (Paulus & Stein, 2006); however, we would add the posterior cingulate cortex and, with risk assessment in particular (McNaughton & Corr, 2018), there is an important role for subcortical “survival circuits” (Mobbs & LeDoux, 2018) that include the dorso-lateral and ventro-lateral periaqueductal grey, anterior and lateral hypothalamus, and lateral septum (Motta, Carobrez, & Canteras, 2017). Critically, we see fear as neurally distinct, involving lateral orbital cortex, anterior cingulate, central amygdala, medial hypothalamus, and dorso-medial periaqueductal gray.

The 3-system (approach, withdrawal, conflict) hierarchical neuropsychology we have described is also relevant to the trait considerations of section III.6. “These systems mediate fluid moment-by-moment reactions to changing stimuli, with relatively stable person-specific sensitivities to these stimuli manifested in personality traits” (Corr et al., 2013, p. 158); and are the basis for the Reinforcement Sensitivity Theory of personality (see Corr, 2008). Our perspective (avoiding the ambiguity of “reward”) suggests that attack (as a predatory approach tendency) and defense (functioning to allow withdrawal) likely depend on fundamentally similar hierarchical system architectures. Apparent prefrontal versus subcortical control differences between them likely depend on the usual difference in “motivational distance” in their eliciting situations. Initially, at least, a predator will be at a large appetitive distance from the prey, requiring extensive planning of its attack. Especially where an ambush is involved, the defensive response by the prey will be immediate and even (at zero defensive distance) undirected. Impulse control also involves a balance between approach motivation and inhibition. The strength of inhibition can be affected by variations in conflict sensitivity (Gray & McNaughton, 2000) and in loss aversion (Tversky & Kahneman, 1991); and approach can vary with the strength of delay discounting (Frost & McNaughton, 2017). The effects of traits on attack and defense clearly require a highly nuanced approach.

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Figure 1

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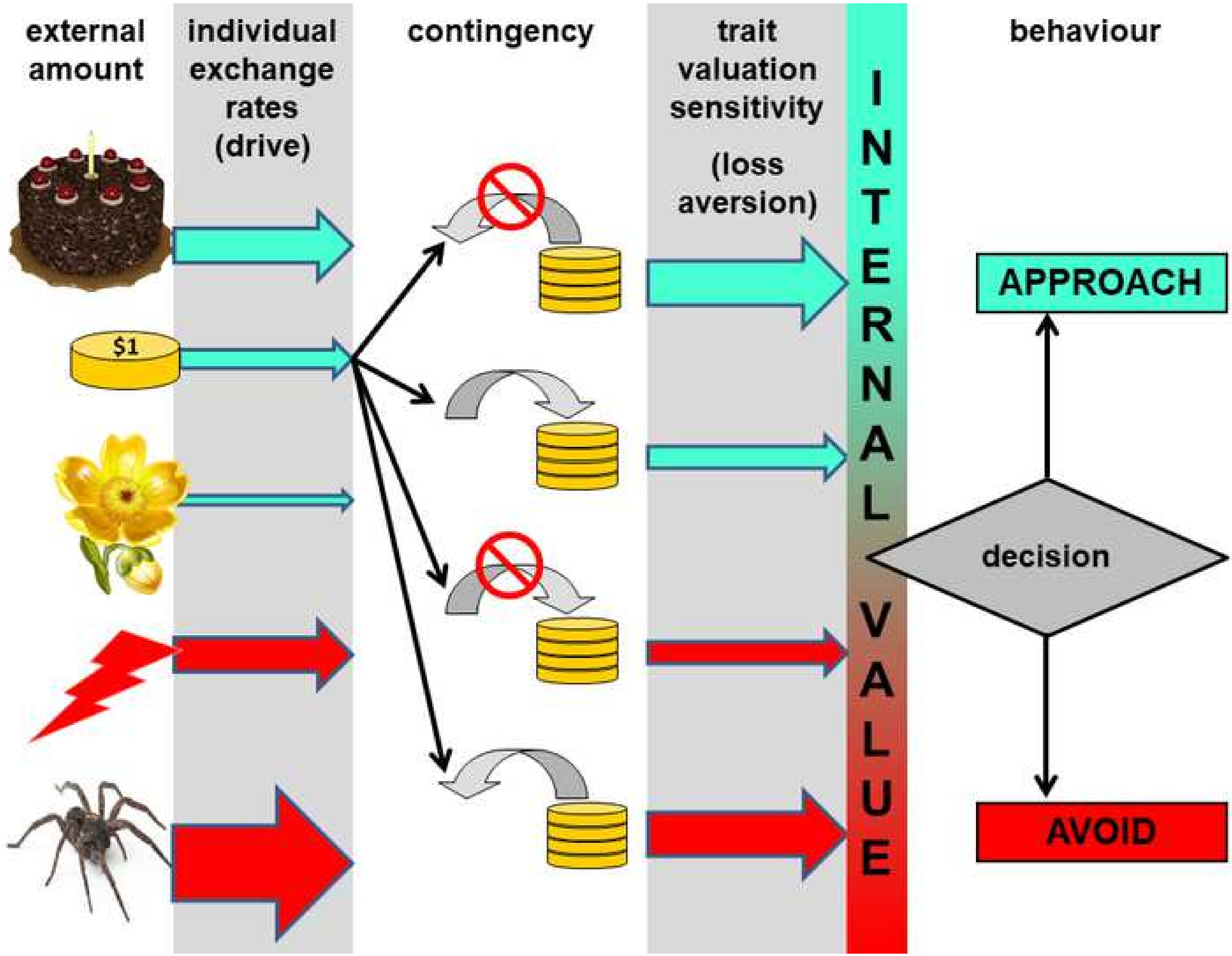
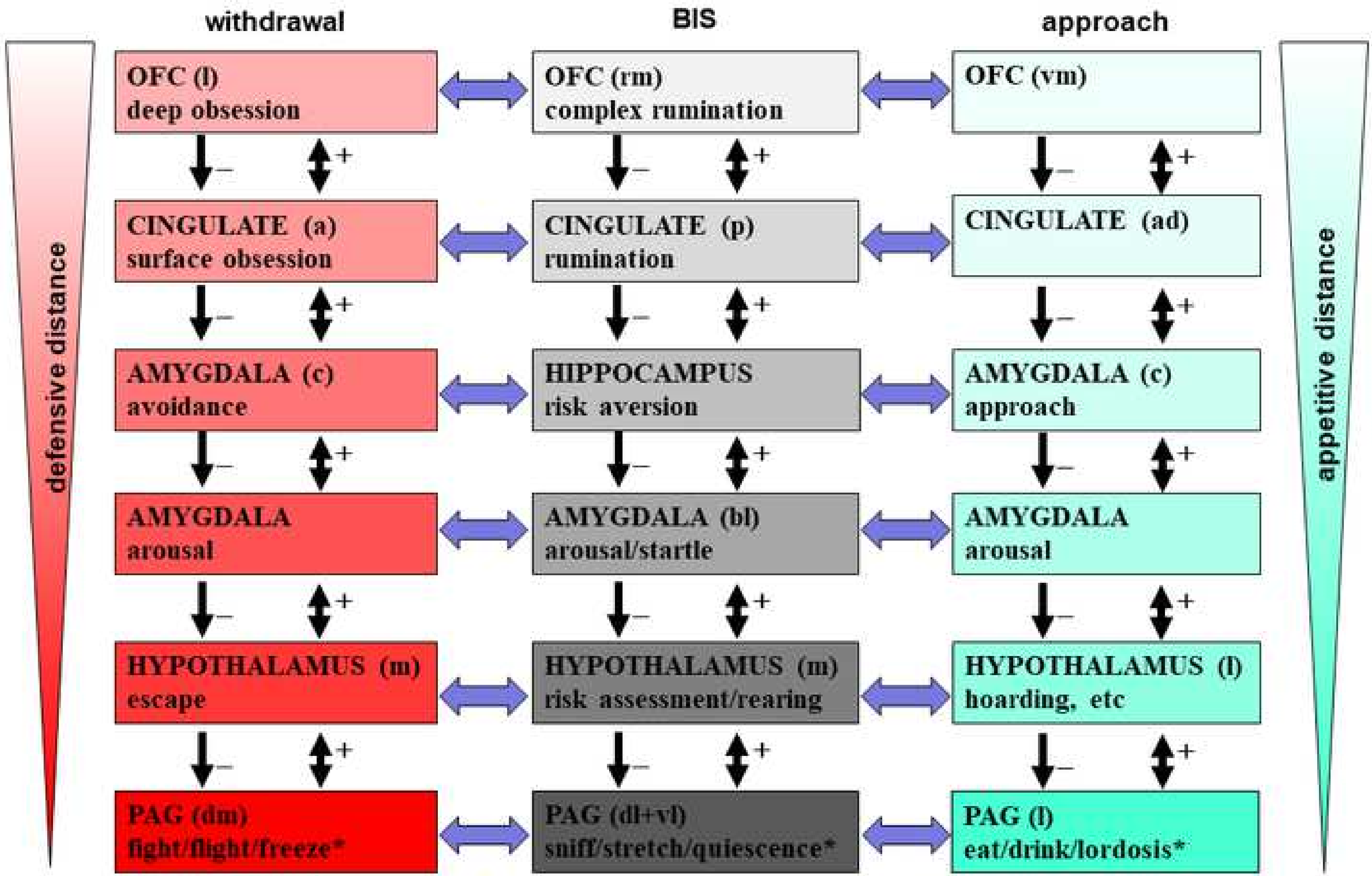


Figure 2


withdrawal
BIS
approach
defensive distance
appetitive distance
OFC (l)
deep obsession
OFC (rm)
complex rumination
OFC (vm)
CINGULATE (a)
surface obsession
CINGULATE (p)
rumination
CINGULATE (ad)
AMYGDALA (c)
avoidance
HIPPOCAMPUS
risk aversion
AMYGDALA (c)
approach
AMYGDALA
arousal
AMYGDALA (bl)
arousal/startle
AMYGDALA
arousal
HYPOTHALAMUS (m)
escape
HYPOTHALAMUS (m)
risk assessment/rearing
HYPOTHALAMUS (l)
hoarding, etc
PAG (dm)
fight/flight/freeze*
PAG (dl+vl)
sniff/stretch/quiescence*
PAG (l)
eat/drink/lordosis*