

## Letter

The Insidious Number  
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We recently joined other researchers [1–5] in challenging the popular assumption that ‘consciousness’, ‘efficiency’, ‘intentionality’, and ‘controllability’ are correlated such that they form two clusters – those typically called ‘Type 1’ and ‘Type 2’, which we refer to collectively as the dual-process typology. More specifically, we argued that (i) these processing features have never been shown to correlate with one another, (ii) there are good reasons to assume that the features are, in fact, completely uncorrelated, and (iii) the features are incoherent, therefore (iv) the dual-process typology should be abandoned [6].

In their commentary, Pennycook, De Neys, Evans, Stanovich, and Thompson (hereafter, PDES&T) seem to agree that cognitive scientists should not assume that processing features are correlated [13]. They say we went awry, however, because the dual-process typology is ‘outdated’. For instance, PDES&T state that Evans and Stanovich (the third and fourth authors of PDES&T) ‘explicitly argued against assuming an alignment of the numerous characteristics that have been assigned to so-called “Type 1” and “Type 2” processes . . .’. PDES&T also state that, in their opinion, featural alignment ‘is not a necessary requirement of dual-process theory’. The sole requirement for dual-process theory, they believe, is the existence of one dichotomous feature – this ‘defining feature’, as they call it, need not correlate with anything for dual-process theory to be valid.

We wish to make two points. First, to our knowledge, hardly any dual-process advocates agree with PDES&T that the

alignment assumption is outdated and unnecessary for dual-process theory (and for good reason; see Box 1). In fact, PDES&T provide no evidence that these views are held by anyone but them, and they acknowledge that researchers, public policy experts, and some dual-process theorists ‘. . . assume an alignment or correlation between various features.’ At worst, then, we critiqued a set of assumptions that are held by most, but not all.

Second, it is interesting to note that the correlation assumption tends to seep into PDES&T’s writing, despite the fact that PDES&T reject it and consider it irrelevant to the central premise of dual-process theory. For example, the following statement appears in the 2013 article by Evans and Stanovich [7] – the article in which they are said to have ‘. . . argued against assuming an alignment of the numerous characteristics that have been assigned to so-called “Type 1” and “Type 2” processes . . .’:

. . . the defining characteristic of Type 1 processes is their autonomy. They . . . make minimal demands on working memory resources . . . the execution of Type 1 processes is mandatory when their triggering stimuli are encountered and they are not dependent on input from high-level control systems. Autonomous processes have other correlated features—their execution tends to be rapid, they do not put a heavy load on central processing capacity, they tend to be associative . . . (p. 236).

Later, Evans and Stanovich [8] state that ‘there are good theoretical reasons for

some features to be correlated’ (p. 265) – this quote appears under the subheading: ‘Why some features are imperfectly correlated: The example of normative responding’. The next year, Stanovich *et al.* [9] wrote this:

Type 2 processing enables us to solve a wide range of novel problems, and solve them with great accuracy. However, this power comes with a cost. Type 2 processing takes up a great deal of attention, tends to be slow, tends to interfere with other thoughts and actions that we are carrying out, and requires great concentration that is often experienced as aversive. In contrast, Type 1 processes are low in computational power but have the advantage that they are low in cost. These mechanisms cannot solve a wide range of problems and do not permit fine-grained accuracy, but they are fast acting, do not interfere with other ongoing cognition, require little concentration, and are not experienced as aversive. (p. 148).

Pennycook [10], the lead author of PDES&T, wrote the following in 2015:

Human reasoning and decision-making is thought to involve two distinct types of processes . . . : Type 1 processes that are intuitive, fast, autonomous, and high capacity; and Type 2 processes that are reflective, slow, and resource demanding. Type 1 processes are thought to provide default outputs that may be acted upon as explicit representations manipulated in working memory via Type 2 processing.

De Neys [11], the second author of PDES&T, wrote the following in 2017:

## Box 1. A Dual-Process Theory without Correlated Features Is Not a Theory

PDES&T never explain how a theory could possibly consist of a single ‘defining feature’ if the ‘defining feature’ is not correlated with any other features. Theories must generate predictions [12], and it is unclear how any predictions can be derived from a ‘defining feature’ that is not correlated with anything. Indeed, PDES&T insist that the ‘defining feature’ of a dual-process theory need not correlate with effort, speed, controllability, intentionality, awareness, erroneous responding, or any other feature that has been associated with Type 1 and Type 2 processing – as far as we can see, such a dual-process ‘theory’ would be incapable of making a single prediction. Thus, it seems to us that when PDES&T say that zero degree of featural alignment is required for dual-process theory, they are saying something deeply incoherent – that is, they are saying that dual-process theory need not make predictions.

Type 1 processing is fast, autonomous, does not require working memory, operates unconsciously and immediately triggers an answer. Type 2 processing puts a heavy load on working memory, operates consciously, controlled and relatively slow.

Apparently, the dual-process typology is quite insidious! PDES&T continue in practice to perpetuate the typology's assumption of correlated processing features – while at the same time explicitly rejecting it here as 'largely irrelevant to current investigations of [dual-process] theory'. Moreover, PDES&T did not take issue with the central content of our critique, instead making only the irrelevant (and tenuous) claim that our critique does not apply to their personal views. This leaves our

original conclusion still standing: the dual-process typology should be abandoned.

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