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Methodology and Research Practice

Does Speeded Decision-Making Reveal Tacit Teleological Tendencies?

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Previous research suggests that people implicitly believe that biological and nonbiological natural entities exist to fulfil certain functions (i.e., people hold implicit teleological beliefs). The standard experimental paradigm used to demonstrate this is to compare rates of teleological acceptance in an un-speeded condition to acceptance in a speeded condition. As speeded decision-making limits the opportunity to engage in reflective thought, increased rates of teleological acceptance relative to the un-speeded condition are said to provide evidence of implicit teleological beliefs. Across two large online studies, we show that due to the exclusion criteria typically used in this paradigm, the included and excluded participants vary systemically in important ways between conditions, and that increased rates of teleological acceptance during speeded responding does not provide evidence of implicit teleological beliefs. Rather, the difference between conditions can be explained by increased acceptance of explanations which are objectively false. Furthermore, we show that a key assumption underpinning the use of this paradigm – that accepting teleological explanations should be effortless and rejecting them should require effort – is not supported by the data. These results highlight not only a methodological issue, but also a theoretical issue in the current literature. We discuss the implications of these findings in the context of existing theoretical and empirical literature on teleological reasoning and dual-process theory more generally.

1. Introduction

Why are you reading this article? You might answer this question by referring to a series of events in your past which culminated in an interest in teleological reasoning or speeded decision-making tasks. Another possible answer is that you are reading this article to learn whether speeded decision-making can reveal tacit teleological tendencies. Whereas the former is a causal explanation about teleology, the latter is a teleological explanation about teleology. Put simply, teleological explanations are those in which something is explained with reference to a function, outcome, or goal (Hempel & Oppenheim, 1948). Teleological reasoning is commonly used to explain the actions of intentional agents (as in the example above), the existence of human-made artefacts (e.g., "pens exist for writing"), and sometimes controversially (see Dennett, 2017), biological traits (e.g., "birds have wings in order to fly"). For intentional action and the existence of human-made artefacts, teleological reasoning is appropriate because both can be explained with reference to the intentions of an agent. If an agent creates a pen with the intention that this device will allow him or her to write, then that pen exists *for* writing. In the case of biological traits, teleological reasoning is appropriate not because of intentional action, but because of the consequence aetiology of natural selection (Dennett, 2017; Lombrozo & Carey, 2006; Neander, 1991; Wright, 1976). That is, "birds have wings *in order to* fly", because the function of flight resulted in fitness advantages for those creatures with ancient wing-like structures. The function that wings serve, is the very reason for their current existence.

1.1. Intention-Based Teleology

Teleological reasoning is sometimes used to explain things which cannot be attributed to the actions of an intentional agent or the consequence aetiology of natural selection. According to Kelemen (1999a) all teleological reasoning is psychologically based in the application of an

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intentional stance (Dennett, 1987). This intention-based theory of teleology posits that from an early age, an intentional stance is applied beyond the domain of explaining intentional action. This is similar to the idea that the actual domain of a modular cognitive process extends beyond the module's proper domain (Boyer, 1994).[1] Just as the application of an intentional stance to its proper domain results in a teleological explanation (e.g., "she crossed the road *in order to* get to the other side"), the application of this stance beyond its proper domain also results in a teleological explanation (e.g., "the computer crashed *in order to* annoy me"). As teleological beliefs are said to be based in the application of this early-developing predictive strategy, according to Kelemen, people often hold teleological beliefs even when the actions of an intentional agent are lacking. One domain of teleological reasoning that has received considerable attention, is the function-based explanation of biological and nonbiological natural entities (e.g., Kelemen, 1999b; Kelemen et al., 2013; Roberts et al., 2021; Willard et al., 2020).

1.1.1. Non-Experimental Evidence for Intention-Based Teleology

Teleological explanations such as "rivers flow downstream in order to get to the ocean", or "trees produce oxygen so that animals can breathe", tend to be accepted by children to a greater extent than adults (Kelemen, 1999c). However, under certain circumstances, adults also display high levels of acceptance for such teleological explanations. Rates of teleological acceptance in adults are positively correlated with anthropomorphism (Roberts et al., 2021; Willard et al., 2020; Willard & Norenzayan, 2013) and belief in God (Kelemen & Diyanni, 2005), suggesting that teleological reasoning is facilitated by notions of intentionality (whether to the natural world itself or to an intending designer). However, even non-religious individuals display evidence of teleological beliefs about biological and nonbiological natural entities (Järnefelt et al., 2015), supporting the view that such beliefs represent somewhat of a default mode of explanation.

Convergent non-experimental evidence also suggests that when people lack an alternative causal explanation, or that when access to the cognitive resources needed to inhibit intuitions is limited, people tend to be more accepting of teleological explanations about biological and nonbiological natural entities. Evidence for this claim comes from studies showing increased teleological acceptance in 1) Alzheimer's patients relative to age-matched controls (Lombrozo et al., 2007); 2) individuals with low levels of formal education relative to those with high levels of formal education (Casler & Kelemen, 2008); and 3) children relative to adults (Kelemen, 1999c). Further non-experimental evidence comes from the negative relationship between performance on the Cognitive Reflection Test (CRT) and rates of acceptance for teleological explanations about biological and non-biological natural entities (Roberts et al., 2021; Zemla et al., 2012). Each item in the CRT is designed to elicit an intuitively appealing, yet incorrect response (e.g., "if you are running a race and you pass the person in second place, what place are you in?"). In this example, the intuitive response is "first place", but the correct response is "second place". As performance on the CRT requires an individual to inhibit the intuitive response, the negative relationship between CRT performance and rates of teleological acceptance has been taken as evidence that compared to low-scoring CRT participants, high-scoring CRT participants may simply be better at inhibiting their teleological intuitions.

1.1.2. Experimental Evidence for Intention-Based Teleology

Experimental evidence for the claim that adults find teleological explanations about biological and nonbiological natural entities compelling, comes from the use of speeded vs. un-speeded decision-making tasks (Kelemen et al., 2013; Kelemen & Rosset, 2009; Mills & Frowley, 2014; Roberts et al., 2020). In this paradigm, participants are allocated to either a speeded or un-speeded condition and are asked to respond "true" or "false" (or "yes" or "no") to a series of teleological test statements and control statements. In the speeded condition, participants typically have either 3200ms (Kelemen et al., 2013; Kelemen & Rosset, 2009; Mills & Frowley, 2014; Roberts et al., 2020) or 5000ms (Kelemen & Rosset, 2009; Mills & Frowley, 2014; Rottman et al., 2017) to respond to each statement.[2] The logic behind using a speeded decision-making paradigm in the study of tacit teleological tendencies, is based in dual-process theories of reasoning (e.g., De Neys, 2014; Evans & Stanovich, 2013; Pennycook et al., 2015). As time-pressure limits the opportunity to reflect upon and inhibit an initial response, responses in the speeded condition are thought to provide an indication of pre-reflective belief (Kelemen et al., 2013). Consistent with the non-experimental evidence, studies employing this paradigm have reported significantly greater teleological acceptance in the speeded condition compared to the un-speeded condition.

1 Although a discussion of modularity is beyond the scope of the current paper, there are many accessible sources on this topic (e.g., Grossi, 2014; Kurzban, 2010). Modularity theory posits that certain neural circuits are domain specific (Fodor, 1983). That is, cognitive modules selectively respond to certain stimuli in the environment. By the *proper domain* of a module, we mean the class of stimuli that a given cognitive process evolved "in response to" (e.g., a face detection module afforded fitness advantages to organisms with this neural circuit by allowing them to recognise faces of conspecifics). By the *actual domain* of a module, we mean *all* the stimuli to which a given cognitive process responds to (e.g., a face detection module may respond to masks because masks resemble faces).

2 The instruction to "respond quickly" has also been used by Preston and Shin (2021). However, this study did not include an actual time limit.

1.1.3. Problems with Speeded Decision-Making

Despite the consistency between experimental and non-experimental evidence, a potential problem with the speeded vs. un-speeded paradigm, as it is commonly used, is that it may lead to selection bias. Inclusion criteria vary across studies, but participants in both conditions are typically required to respond correctly to a certain percentage of control statements, ranging from just 25% correct (Kelemen & Rosset, 2009), to over 80% correct (Kelemen et al., 2013; Roberts et al., 2020). Additionally, participants in the speeded condition are required to answer a certain percentage of test statements within the time limit, ranging from 25% (Kelemen & Rosset, 2009), to over 75% (Kelemen et al., 2013; Roberts et al., 2020). These inclusion criteria can result in a higher rate of exclusion in the speeded condition compared to the un-speeded condition. For example, despite Roberts et al. (2020) allocating 138 participants to either a speeded or un-speeded condition at a ratio of 1.5 (speeded): 1 (un-speeded), only 34 participants in the speeded condition and 54 in the un-speeded condition met the inclusion criteria. The different rates of exclusion mean it is possible that the participants vary systematically in certain ways between the two conditions.

As mentioned previously, there is a negative relationship between CRT performance and rates of teleological acceptance in the absence of time pressure (Roberts et al., 2021; Zemla et al., 2012). Given that each question on the CRT is designed to elicit an intuitively appealing incorrect answer, performance on the CRT requires an individual to first inhibit their intuitions, and to then reflect to produce the correct response. This leads to two possibilities regarding the relationship between CRT performance and inclusion in the decision-making task. If high-scoring CRT participants are more likely to pause and reflect before providing an answer, this could lead to the systematic exclusion of these individuals in the speeded condition if they fail to answer a sufficient percentage of test statements within the time-limit. Due to the negative relationship between CRT performance and teleological acceptance, excluding high-scoring CRT participants in the speeded condition could artificially increase rates of teleological acceptance in this condition. However, it is also conceivable that high-scoring CRT participants may be better able to answer quickly when under time pressure to respond. As such, this could lead to the systematic exclusion of low-scoring CRT participants in the speeded condition, thereby artificially *decreasing* rates of teleological acceptance in this condition. Either of these possibilities would be problematic for the claim that speeded decision-making can provide an accurate assessment of tacit teleological tendencies.

While the finding of increased teleological acceptance in the speeded compared to un-speeded condition appears to be robust (Kelemen et al., 2013; Kelemen & Rosset, 2009; Roberts et al., 2020; but see Liquin & Lombrozo, 2018 - study 5), this alone is not evidence of tacit teleological tendencies. The claim that this paradigm provides evidence of such tacit tendencies, rests on the idea that the difference in responses between conditions is due to the speeded condition limiting the opportunity to inhibit reflective thought. However, in this paradigm, participants also respond to a series of objectively false and objectively true control statements in either condition. As such, unless we are also willing to concede that speeded decision-making provides evidence of implicit belief in things that are objectively false (e.g., "people smoke cigarettes in order to get lung cancer"), or evidence of implicit *disbelief* in things that are objectively true (e.g., "doctors prescribe antibiotics in order to treat infections"), the effect of time pressure must be greater for teleological test statements than for control statements.

At present, there is little evidence to suggest that the effect of time pressure is greater for teleological test statements than for control statements. This is not necessarily due to the absence of such evidence in the data, but rather, due to the ways in which results have been reported, and to the slight differences in procedures across studies. For example, by presenting groups of participants with statements on an overhead screen for varying durations (un-speeded; moderately-speeded, 5000ms; and fast-speeded, 3200ms) and asking them to respond by ticking boxes on an answer sheet, studies have found an effect of speed on response accuracy for certain teleological statements (Kelemen & Rosset, 2009; Mills & Frowley, 2014). When looking at control statement accuracy, Kelemen and Rosset (2009) found that un-speeded participants were significantly less accurate than the other groups (Study One), although this effect failed to replicate in a second study (see also Mills & Frowley, 2014). However, given the manipulation of speed in these studies involved participants being presented with statements on an overhead screen and responding by ticking boxes on an answer sheet, it was possible for participants to respond after the statements had disappeared from the screen. Therefore, it may not be so surprising that using this procedure, participants were still highly accurate in responding to control statements in the speeded conditions.

A more rigorous approach has been to use computerised tasks to limit not only the duration of presentation, but also the response window. Using this approach, studies have found an interaction between condition (un-speeded, speeded) and statement-type accuracy (teleological, control). However, the way in which this interaction has been reported does not necessarily provide evidence of tacit teleological tendencies. Using the speeded vs. un-speeded paradigm to investigate the teleological beliefs of professional scientists, Kelemen et al. (2013) found a larger mean difference between conditions for test statements (14% difference) than control statements (3% difference). Similarly, using an undergraduate sample, Roberts et al. (2020) found a larger mean difference between conditions for test statements (18.9% difference) than control statements (3.5% difference). Such results have also been replicated in a Chinese adult sample (Rottman et al., 2017), with a larger mean difference between conditions for test statements (14% difference) than control statements (6% difference). Examination of the descriptive statistics in these studies show that although the mean differences were indeed larger for test statements than for control statements, since control statements tend to be answered quite accurately, the

variation in responses was also larger for test statements than for control statements. As measures of effect size take account of not only a difference in means, but also some component of error variance, a greater mean difference in response accuracy between conditions for test statements than for control statements, does not necessarily equate to a larger effect size for the former than for the latter.

Finally, even if it can be shown that speeded decision-making has a greater effect on test statement accuracy than on control statement accuracy, this would still not necessarily provide evidence of implicit teleological beliefs. As placing participants under cognitive load has been shown to increase yea-saying (Knowles & Condon, 1999), it is possible that speeded decision-making merely increases the likelihood of accepting statements as true. As the control statements used in the previously mentioned studies describe things which are *objectively* true or false, when presented without a time-limit, they tend to be accepted at close to ceiling and floor levels, respectively (Roberts et al., 2021). If speeded decision-making does increase the likelihood of accepting statements as true, then comparing test statement accuracy to the aggregate of all control statements may be problematic, as the true control statements could reduce the difference in accuracy between conditions for control statements as a whole. As teleological test statements describe beliefs that adults are hypothesised to inhibit, a stronger test of the hypothesis that speeded decision-making can uncover tacit teleological tendencies, would be to compare the effect of time pressure for teleological test statements relative to control statements that are objectively false. To provide evidence of tacit teleological tendencies, this paradigm must be able to demonstrate that the effect of time pressure for test statements is significantly greater than the effect of time pressure for false control statements.

1.2. Current Studies

In summary, there are three key issues in studies that have used the speeded vs. un-speeded decision-making paradigm to explore implicit teleological beliefs. First, differing inclusion criteria between experimental conditions may lead to the systematic exclusion of certain individuals from one condition, but not the other. Second, reported interactions between speed and item type have not included enough information to ascertain whether implicit teleological beliefs are truly driving the effects of interest. Third, comparing responses to teleological test statements to the aggregate of all control statements (i.e., those which are objectively false and those which are objectively true), may obscure differences in accuracy between conditions. In the current two studies, we aimed to explore these issues and determine whether the speeded decision-making paradigm provides evidence of tacit teleological tendencies.

These studies were approved by the Macquarie University Human Research Ethics Committee (protocol number 5201949787325), under the project titled "The Intentional Stance and Teleological Endorsement". For both studies in this manuscript, we report all measures, conditions, data exclusions, and how sample sizes were determined.

2. Study One

In Study One, we sought to explore the issues raised above using a large online sample. First, we investigated whether the typical speeded vs. un-speeded paradigm results in selection bias. Due to the higher expected rate of exclusion in the speeded condition compared to the un-speeded condition, and due to the additional inclusion criterion and greater difficulty of the task in the former, we predicted that participants who met inclusion criteria in the speeded condition would differ significantly in their ability to inhibit intuitions relative to participants who did not meet inclusion criteria in this condition. Second, we investigated whether the speeded vs. un-speeded paradigm provides evidence of a dissociation between implicit and explicit teleological beliefs. If implicit teleological beliefs are truly driving the effects of interest, then the effect of time pressure should be greater for teleological test statements than for control statements. Specifically, any increase in rates of acceptance for teleological test statements under time pressure, should not be attributable to acceptance of statements that are objectively false. The preregistration for Study One can be accessed at https://osf.io/v83zm.

2.1. Methods

2.1.1. Participants

An international pool of 273 native English-speakers were recruited through the online service, Prolific. Our choice of sample size was based on Kelemen et al. (2013), who found an interaction between statement-type (test, control) and condition (speeded, un-speeded), with an effect size of η^2 = .06. An a-priori power analysis in G*Power 3.1 (Erdfelder et al., 2009), revealed that a sample of N = 208 was required to detect an effect of this size with power of .95. We purposely over-recruited to allow for the expected high rate of exclusion in the speeded condition. Participants received payment of £2.22 for taking part in an online study that took approximately 15 minutes to complete. As we aimed to investigate whether inclusion in the speeded condition varied systematically with the tendency to inhibit intuitions, and as highly educated individuals tend to be both less teleological (Kelemen et al., 2013) and more analytical (Purcell et al., 2020), only individuals with formal educational qualifications no higher than an undergraduate university degree were eligible to participate. Before exclusion, the sample consisted of 92 atheists, 64 agnostics, 111 Christians,[3] 5 Muslims, and 1 Jew. Ages ranged from 16 to 73 (M = 32.77, SD = 13.37), with 141 females, 130 males, and two non-binary.

2.1.2. Materials

2.1.2.1. Teleological Beliefs Scale. Participants completed the Teleological Beliefs Scale (TBS: Roberts et al., 2021) which measures teleological beliefs about biological and non-biological natural entities. The TBS contains 98 statements across six categories: biological teleological test

(*n* = 14; e.g., "Plants consume CO2 in order to reduce greenhouse gases"), non-biological teleological test (*n* = 14; e.g., "The Earth has a moon in order to control the tides"), false causal (*n* = 25; e.g., "Pebbles have rounded edges because they are little"), false teleological (*n* = 10; e.g., "Houses have doorbells in order to make dogs bark"), true causal (*n* = 25; e.g., "Fireworks explode because gunpowder ignites when a fuse is lit"), and true teleological (*n* = 10; e.g., "Alarm clocks beep in order to wake people up"). In the current study, we collapsed both categories of test statements, both categories of false control statements, and both categories of true control statements. Participants responded "true" or "false" to each statement, and a total score for each category was calculated as the proportion of statements endorsed. The teleological test statements displayed good internal consistency (α = .894).

2.1.2.2. Attributions of Intentionality. To replicate findings of teleological beliefs about biological and non-biological natural entities being positively predicted by attributions of intentionality (e.g., Roberts et al., 2021; Willard et al., 2020; Willard & Norenzayan, 2013), we included measures of anthropomorphism and religious belief.

2.1.2.2.1. Anthropomorphism. Participants completed the Anthropomorphism Questionnaire (AQ: Neave et al., 2015), which contains 20 items measuring anthropomorphic experiences in childhood (e.g., "When I was a child, I held birthday parties for my favourite toys") and adulthood (e.g., "I sometimes feel that the sea can be angry"). Each item is scored on a scale from 0 (*Not at all*) to 6 (*Very much so*). A total score is obtained by summing all items, such that scores have a potential range of 0 to 120. Internal consistency for the AQ was excellent (α = .939).

2.1.2.2.2. Religious Belief. Participants completed a reduced version of the Centrality of Religiosity Questionnaire (r-CRS: Huber & Huber, 2012). The full version of the CRS contains 15 items balanced across five subscales: experience (e.g., "How often do you experience situations in which you have the feeling that God or something divine intervenes in your life?"), ideology (e.g., "To what extent do you believe that God or something divine exists?"), intellect (e.g., "How often do you think about religious issues?"), private practise (e.g., "How often do you pray?"), and public practise (e.g., "How often do you take part in religious services?"). As belief in God is not necessarily related to a desire to learn about religious topics (intellect subscale) or attendance at religious services (public practise subscale), we used a reduced version of the CRS which contained only the experience, ideology, and private practise subscales (Roberts et al., 2021). Responses to questions about the frequency of personal prayer were scored on a scale from 1 (*Never*) to 8 (*Several times a day*) and then later recoded to a five-point scale (Huber & Huber, 2012). The remaining questions were scored on a scale from 1 (*Never/ Not at all*) to 5 (*Very often/ Very much so*). A total score is calculated by taking the mean of all items. The r-CRS displayed excellent internal consistency (α = .967).

2.1.2.3. Inhibition of Intuitions. To investigate whether the tendency to inhibit intuitions negatively predicted scores on the TBS, and whether participants in the speeded condition were systematically excluded according to their tendency to engage in reflective thought, participants completed an extended version of the Cognitive Reflection Test (CRT). The original CRT contains three questions (e.g., "A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?": Frederick, 2005). In the current study, we used slightly re-worded versions of the original three questions (e.g., "The ages of Mark and Adam add up to 28 years. Mark is 20 years older than Adam. How many years old is Adam?": Pennycook & Rand, 2019). Additionally, the extended version of the CRT contains four less math focused questions (e.g., "Emily's father has three daughters. The first two are named April and May. What is the third daughter's name?": Thomson & Oppenheimer, 2016). Each question is designed to elicit an intuitively appealing yet incorrect answer which must be inhibited to produce the correct response. A total score on the CRT is calculated as the number of correct responses, such that scores have a possible range of 0 to 7. The internal consistency of the CRT was acceptable (α = .725).

2.1.3. Procedure

Participants were provided a link which redirected them to the study which was hosted on Gorilla.sc. After providing informed consent, participants were quasi-randomly assigned to either a speeded or un-speeded condition of the TBS to ensure a balanced design. In the un-speeded condition, participants were instructed to "*read each statement carefully and respond according to what you believe*", whereas in the speeded condition, participants were instructed to "*read each statement and respond as quickly and as accurately as possible*". Participants responded "true" or "false" to each item by pressing the *J* or *F* key, respectively. In the speeded condition, participants had 3200ms in which to respond to each statement in the TBS. If they failed to respond within 3200ms, the next item appeared on the screen. In both conditions, once an item was first presented on the screen, there was a 500ms window in which responses were not recorded. This was both to encourage participants to process the statement, and to ensure that participants in the speeded condition did not begin responding to a statement at 3200ms but make their response once the following item was presented. After completing the TBS, participants completed the Anthropomorphism Questionnaire, reduced Centrality of Religiosity Scale, and extended Cognitive Reflection Test in a Latin square design.

3 Participants were able to select "Christian" or "Catholic". Although Catholicism is a form of Christianity, we found in previous research that a substantial proportion of Catholics selected "Other" as their affiliation and then specified that they were Catholic in a free-response box. In the current sample, 72 selected Christian and 39 selected Catholic.

Table 1. Correlations Between Teleology and Predictor Variables in Study One Prior to Exclusion

	1	2	3	4	5	6
1. Teleology	-					
	-					
2. False Control	-.587***	-				
	[-.66, -.50]	-				
3. True Control	-.247***	.556***	-			
	[-.36, -.13]	[.47, .63]	-			
4. Anthropomorphism	.181**	-.123*	-.026	-		
	[.06, .29]	[-.24, -.01]	[-.15, .09]	-		
5. God	.213***	-.197**	-.136*	.095	-	
	[.10, .32]	[-.31, -.08]	[-.25, -.02]	[-.02, .21]	-	
6. Inhibition	-.414***	.406***	.170**	-.105	-.181**	-
	[-.51, -.31]	[.30, .50]	[.05, .28]	[-.22, .01]	[-.29, -.06]	-

Note. Pearson's *r* correlations with 95% confidence intervals [L, U]. *N* = 273 for all cells. "Teleology" represents agreement with test statements, whereas "False" and "True" represent accuracy for each category of control statements. "Anthropomorphism" = Anthropomorphism Questionnaire; "God" = reduced Centrality of Religiosity Scale; "Inhibition" = Cognitive Reflection Test.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Consistent with previous studies (Kelemen et al., 2013; Roberts et al., 2020), participants in either condition were excluded for failing to correctly respond to 80% of control statements, or for failing to respond to 75% of teleological test statements within the time-limit in the speeded condition. In the un-speeded condition, 11 participants failed to meet the inclusion criterion (n = 100), whereas in the speeded condition, 62 participants failed to meet the inclusion criteria (n = 100). The difference in inclusion between conditions was statistically significant $\chi^2(1) = 25.62$, $p < .001$.

2.2. Results

2.2.1. Correlations Between Predictors and Responses on the Teleological Beliefs Scale

We first explored the relationships between acceptance of teleological explanations about biological and non-biological natural entities, accuracy in responding to control statements that were objectively true or objectively false, and anthropomorphism, belief in God, and inhibition of intuitions. As shown in Table 1, before participant exclusion, anthropomorphism and belief in God displayed significant positive relationships with teleological acceptance, whereas inhibition of intuitions displayed a significant negative relationship with teleological acceptance. Anthropomorphism and belief in God were also negatively related to false control statement accuracy, whereas inhibition of intuitions was positively related to false control statement accuracy.

2.2.2. Inclusion and Exclusion

Scores on the CRT displayed moderate to strong significant relationships with both teleological acceptance and accuracy for false control statements. As accuracy on control statements was one of inclusion criteria, next we explored whether scores on the predictor variables differed between those who met and those who did not meet the inclusion criteria.[4] As shown in Table 2, there was no significant difference in anthropomorphism between included and excluded participants, $t(129.75) = -0.62$, $p = .535$. However, compared to excluded participants, those who met inclusion criteria expressed less belief in God, $t(119.83) = -2.35$, $p = .020$, and were better able to inhibit their intuitions, $t(118.39) = 4.55$, $p < .001$.

2.2.3. The Effect of Speed on Teleology

To investigate whether speeded decision-making reveals tacit teleological tendencies, using only participants who met the inclusion criteria, we compared responses to the teleological test statements and control statements between the speeded and un-speeded conditions. If teleological beliefs about biological and non-biological natural entities are a "developmentally persistent cognitive default" (Kelemen et al., 2013, p. 1075), and if speeded decision-making can be used as a method for uncovering such beliefs, then time pressure should have a significantly greater effect for teleological test statements than for control statements. To allow for a meaningful comparison of statement types, responses to teleological test statements and false control statements were reverse-coded, such that higher scores represented greater accuracy rather than

4 Due to the unbalanced group sizes, we used a series of Welch's two-sample t tests. This approach does not assume homogeneity of variance between the groups.

Table 2. Comparison of Scores on Predictor Variables for Included and Excluded Participants in Study One

	Included	Excluded	Difference	Effect (*d*)
Anthropomorphism (AQ)	30.87 (1.82)	33.03 (2.96)	2.16 (3.50), [-4.71, 9.03]	0.08 [0.00, 0.35]
God (r-CRS)	2.18 (0.08)	2.57 (0.15)	0.39 (0.16), [0.06, 0.73]*	0.33 [0.06, 0.61]
Inhibition (CRT)	3.64 (0.13)	2.41 (0.24)	-1.22 (0.26), [-1.76, -0.69]***	0.65 [0.36, 0.94]

Note. Means are shown with standard errors in parentheses. 95% confidence intervals [L, U] are shown for mean differences and the effect size (Cohen's *d*) of differences. Included n = 200. Excluded n = 73.
* $p < .05$, *** $p < .001$.

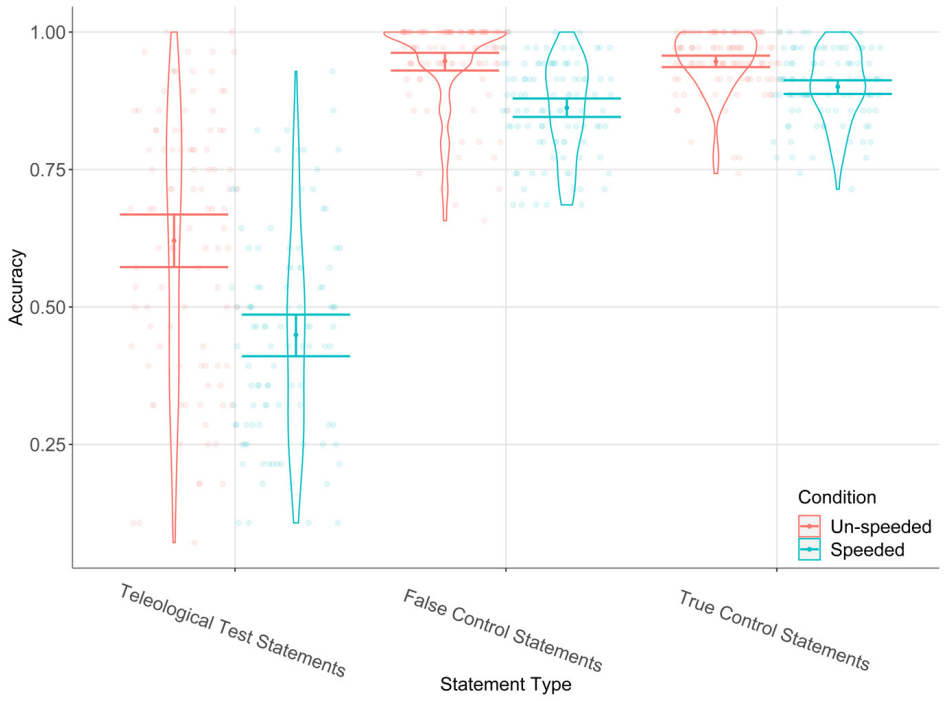

Figure 1. Mean Accuracy Across Statement-Types as a Function of Condition with Exclusion

greater acceptance. We conducted a 2 (condition: speeded, un-speeded) x (3) (statement-type: teleological test, false control, true control) ANOVA with accuracy as the dependent variable.

The effects of condition, $F(1, 198) = 58.49$, $p < .001$, $\eta\rho^2 = .228$, and statement-type, $F(1, 396) = 606.34$, $p < .001$, $\eta\rho^2 = .754$, were both significant, but as shown in Figure 1, were qualified by a significant condition by statement-type interaction, $F(1, 396) = 13.03$, $p < .001$, $\eta\rho^2 = .062$. To explore this interaction, three contrasts were performed in which we compared the difference between conditions on test statement accuracy relative to overall control statement accuracy (contrast 1), test statement accuracy relative to false control statement accuracy (contrast 2), and test statement accuracy relative to true control statement accuracy (contrast 3).

As shown in Table 3, contrary to what would be expected if the speeded decision-making paradigm revealed tacit teleological tendencies, the effect of time pressure on control statement accuracy in aggregate, $t(198) = 9.19$, $p < .001$, was stronger than the effect of time pressure on teleological test statement accuracy, $t(198) = 5.57$, $p < .001$. This difference was statistically significant ($F(1, 198) = 14.18$, $p < .001$, $\eta\rho^2 = .067$). Similarly, the effect of time pressure on false control statement accuracy, $t(198) = 7.27$, $p < .001$, was stronger than the effect of time pressure on teleological test statement accuracy ($F(1, 198) = 10.99$, $p = .001$, $\eta\rho^2 = .053$). However, the effect of time pressure on teleological test statement accuracy was stronger than the effect of time pressure on true control statement accuracy, $t(198) = 5.50$, $p < .001$, and this difference was statistically significant ($F(1, 198) = 15.62$, $p < .001$, $\eta\rho^2 = .073$). These results suggest that with the inclusion criteria of > 80% accuracy on control statements and > 75% of test statements answered within the time limit, speeded responding has a greater effect on control statement accuracy than on teleological test statement accuracy. This effect was driven by decreased accuracy for false control statements in the speeded condition rather than by changes in teleological endorsement.

2.2.4. Response Latencies

Although the preceding results do not necessarily show that teleological tendencies do not exist, they do demonstrate a problem with the speeded decision-making paradigm in the study of teleological tendencies. In an ex-

Table 3. Accuracy for Statement Types as a Function of Condition after Participant Exclusion in Study One

	Un-Speeded	Speeded	Difference	Effect (*d*)
Teleological Test	0.62 (0.24)	0.45 (0.19)	0.17 [0.11, 0.23]***	0.79 [0.49, 1.09]
Control Aggregate	0.95 (0.05)	0.88 (0.05)	0.07 [0.05, 0.08]***	1.31 [0.97, 1.64]
False Control	0.95 (0.08)	0.86 (0.09)	0.08 [0.06, 0.11]***	1.03 [0.72, 1.34]
True Control	0.95 (0.05)	0.90 (0.06)	0.05 [0.03, 0.06]***	0.78 [0.48, 1.08]

Note. Means are shown with standard deviations in parentheses. 95% confidence intervals are shown [L, U] for mean differences between conditions and for the effect size (Cohen's *d*) between conditions.
*** $p < .001$

ploratory analysis, we investigated response latencies for correctly rejected and incorrectly accepted teleological test statements. If teleological beliefs about biological and non-biological natural entities are a developmentally persistent cognitive default, then people should be faster to accept than to reject such explanations. Indeed, the very basis of speeded decision-making as a method of demonstrating such tendencies, rests on the idea that rejecting such explanations requires cognitive effort, and hence, time.

Using only the un-speeded condition, mean latencies were calculated separately for correctly rejected and incorrectly accepted teleological test statements for each participant. Standardised scores were computed based on these means, resulting in the exclusion of one participant with a z-score of 15.56. All other mean z-scores were within a range of -0.42 to 1.16. Next, standardised scores were calculated for individual trials. Latencies for trials with a corresponding z-score greater than +/- 3 were replaced with the mean latency of either correctly or incorrectly answered trials depending on the response. Two participants who responded correctly to every statement were excluded, leaving 97 participants. A paired t-test revealed no significant difference in response latencies between correctly rejected (M = 4456.34, SD = 1910.15) and incorrectly accepted teleological test statements (M = 4353.89, SD = 2440.54), $t(96) = 0.49$, $p = .628$. To better understand this null finding, we ran a Bayesian paired t-test using an uninformative prior. This test provided moderate support for the null hypothesis of no difference between conditions ($BF_{10} = 0.172$).

A possible objection to the previous analysis is that perhaps certain teleological test statements tend to be answered correctly, whereas certain others tend to be answered incorrectly. If response latencies differed systematically across statements, then the previous null result could be due to statement-specific variation in latencies. That is, perhaps people *are* faster to accept than to reject teleological statements about biological and nonbiological natural entities in general, but perhaps the statements in the Teleological Beliefs Scale that people tend to accept, also happen to be those that take longer to process regardless of the response. To rule out this alternative explanation, we repeated the previous paired t-test, but restricted the analysis to statements with a mean accuracy of between 0.4 and 0.6. As before, the paired t-test revealed no significant difference in response latencies between correctly rejected (M = 4800.63, SD = 2550.46) and incorrectly accepted teleological test statements (M = 5048.01, SD = 3601.71), $t(86) = -0.64$, $p = .524$. A Bayesian paired t-test using an uninformative prior provided strong support for the null hypothesis of no difference between conditions ($BF_{10} = 0.077$).[5]

2.3. Discussion

Consistent with previous research, Study One showed that teleological beliefs were negatively related to the tendency to inhibit intuitions (Roberts et al., 2021; Zemla et al., 2012). This negative relationship between inhibition of intuitions and teleological beliefs has been taken as evidence that teleological beliefs can be conceptualised within a dual-process framework. According to this view, teleological beliefs about biological and non-biological natural entities are intuitively appealing, and to not express such beliefs, effortful thought must be engaged (Kelemen et al., 2013; Kelemen & Rosset, 2009). However, Study One identified several problems with the use of speeded decision-making paradigms, on which claims for experimental evidence for the dual-process perspective rest.

First, the rate of participant exclusion in the speeded condition was significantly higher than in the un-speeded condition. Collapsed across conditions, participants who met the inclusion criteria were less religious and better at inhibiting their intuitions. This demonstrates the systematic exclusion of certain individuals in one condition, but not in the other. The direction of this effect was such that individuals who tend to express more teleological beliefs were systematically excluded from the speeded condition, thereby potentially resulting in decreased teleological acceptance in this condition. Second, the effect of time pressure for teleological test statements was weaker than the effect of time pressure for control statements on average. Contrast testing revealed that this difference was driven by reduced accuracy for objectively false control statements in the speeded condition. Rather than time pressure uncovering tacit teleological tendencies, this suggests that time

5 Without the replacement of outliers, the interpretation of response latency comparisons did not change. All statements, $t(97) = -0.86$, $p = .390$; only statements endorsed at moderate rates, $t(97) = 0.36$, $p = .723$.

pressure increases acceptance of things which are false; of which, it could be argued, teleological explanations about biological and nonbiological natural entities are a part.

Finally, although the effect of time pressure on control statement accuracy relative to teleological test statement accuracy highlights a methodological issue, examination of response latencies for correctly rejected and incorrectly accepted teleological test statements suggests a problem with theory. The basis for using speeded decision-making to uncover tacit teleological tendencies, is that additional processing, and hence, time, should be required to inhibit the expression of such beliefs. Contrary to these predictions, we found that response latencies for correctly rejected and incorrectly accepted teleological test statements did not differ.

3. Study Two

Study One showed that participants were systematically excluded from the speeded condition, and that when effect sizes are considered, time pressure appears to increase acceptance of statements that are objectively false rather than uncovering tacit teleological tendencies. As neither of these findings have previously been reported in the literature, in Study Two, we sought to replicate the results of Study One using an undergraduate sample. First, we predicted that participants who met inclusion criteria would be significantly better at inhibiting their intuitions compared to participants who did not meet inclusion criteria. Second, we predicted that the effect of time pressure would be significantly greater for false control statements than for teleological test statements. The preregistration for Study Two can be accessed at https://osf.io/zprxs.

3.1. Methods

3.1.1. Participants

Two-hundred and fifty first-year undergraduate psychology students from Macquarie University in Australia participated in the study in exchange for course credit. This sample size was based on the same considerations as Study One. However, due to a higher-than-expected exclusion rate in the undergraduate sample compared to the online sample of Study One, we finished with a sample size of N = 168 (see section 3.1.3). A sensitivity analysis in G*Power 3.1 (Erdfelder et al., 2009), based on the same interaction term that was used to determine our sample size in Study One, revealed that we were able to detect an effect of η^2 = .06 with power of .90 with this sample. Before exclusion, the sample consisted of 82 agnostics, 72 atheists, 83 Christians, 8 Muslims, 4 Jews, and 1 "other". Ages ranged from 16 to 52 (M = 21.75, SD = 7.17), with 183 females and 67 males.

3.1.2. Materials

The materials were identical to Study One.

3.1.3. Procedure

The procedure was identical to Study One. In the un-speeded condition, 6 participants failed to meet the inclusion criterion, whereas in the speeded condition, 76 participants failed to meet inclusion criteria. This resulted in a final sample of n = 119 in the un-speeded condition, and n = 49 in the speeded condition. The difference in rates of inclusion between conditions was statistically significant $\chi^2(1) = 86.40$, $p < .001$.

3.2. Results

3.2.1. Correlations Between Predictors and Responses on the TBS

As shown in Table 4, before participant exclusion, anthropomorphism was positively correlated with teleological acceptance, whereas inhibition of intuitions was negatively correlated with teleological acceptance. In contrast to Study One, the relationship between belief in God and teleological acceptance was non-significant. Anthropomorphism and belief in God were negatively related to accuracy for false control statements, and inhibition of intuitions was positively related to accuracy for false control statements. Inhibition of intuitions also displayed a significant positive relationship with accuracy for true control statements.

3.2.2. Inclusion and Exclusion

The bivariate correlations conceptually replicated the key findings from Study One. The tendency to inhibit intuitions was significantly related not only to teleological acceptance, but to accuracy for control statements. Given the control statement accuracy inclusion criterion, we sought to replicate the finding that inhibition of intuitions varied systematically with inclusion status. As shown in Table 5, included and excluded participants did not differ significantly on anthropomorphism, $t(143.36) = 1.75$, $p = .082$, or, in contrast to Study One, belief in God, $t(143.41) = 1.36$, $p = .175$. However, consistent with Study One, compared to participants who failed to meet the inclusion criteria, those who met the inclusion criteria were significantly better at inhibiting their intuitions, $t(154.33) = -3.39$, $p = .001$.

3.2.3. The Effect of Speed on Teleology

Using only participants who met the inclusion criteria, we compared responses to the teleological test statements and control statements between the speeded and un-speeded condition. We conducted a 2 (condition: speeded, un-speeded) x (3) (statement-type: teleological test, false control, true control) ANOVA with accuracy as the dependent variable. The effects of condition, $F(1, 166) = 58.57$, $p < .001$, $\eta\rho^2 = .261$, and statement-type, $F(1, 332) = 401.76$, $p < .001$, $\eta\rho^2 = .708$, were both highly significant, but as shown in Figure 2, were qualified by a significant condition by statement-type interaction, $F(1, 332) = 16.38$, $p < .001$,

Table 4. Correlations Between Teleology and Predictor Variables in Study Two Prior to Exclusion

	1	2	3	4	5	6
1. Teleology	-					
	-					
2. False	-.624***	-				
	[-.69, -.54]	-				
3. True	-.159*	.439***	-			
	[-.28, -.04]	[.33, .53]	-			
4. Anthropomorphism	.188**	-.211***	.065	-		
	[.07, .31]	[-.33, -.09]	[-.06, .19]	-		
5. God	.075	-.177**	-.038	.273***	-	
	[-.05, .20]	[-.30, -.06]	[-.16, .09]	[.15, .38]	-	
6. Inhibition	-.219***	.265***	.167**	-.203**	.140*	-
	[-.33, -.10]	[.15, .38]	[.04, .29]	[-.32, .08]	[-.26, -.02]	-

Note. Pearson's *r* correlations with 95% confidence intervals [L, U]. $N = 250$ for all cells. "Teleology" represents agreement with test statements, whereas "False" and "True" represent accuracy for each category of control statements. "Anthropomorphism" = Anthropomorphism Questionnaire; "God" = reduced Centrality of Religiosity Scale; "Inhibition" = Cognitive Reflection Test.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 5. Comparison of Scores on Predictor Variables for Included and Excluded Participants in Study Two

	Included	Excluded	Difference	Effect (*d*)
Anthropomorphism (AQ)	30.48 (1.81)	36.57 (2.96)	6.09 [-0.78, 12.96]	0.25 [0.02, 0.51]
God (r-CRS)	2.38 (0.08)	2.60 (0.13)	0.21 [-0.09, 0.52]	0.19 [0.07, 0.46]
Inhibition (CRT)	3.65 (0.13)	2.85 (0.19)	-0.80 [-1.26, -0.33]**	0.47 [0.19, 0.74]

Note. Means are shown with standard errors in parentheses. 95% confidence intervals [L, U] are shown for mean differences and the effect size (Cohen's *d*) of differences. Included $n = 168$. Excluded $n = 82$.
** $p < .01$.

$\eta\rho^2 = .090$. To explore this interaction, the same three contrasts were performed as in Study One.

As shown in Table 6, contrary to what would be expected if the speeded decision-making paradigm revealed tacit teleological tendencies, the effect of time pressure on control statement accuracy in aggregate, $t(166) = 7.58$, $p < .001$, was stronger than the effect of time pressure on teleological test statement accuracy, $t(166) = 5.60$, $p < .001$. This comparison was statistically significant, $F(1, 166) = 15.55$, $p < .001$, $\eta\rho^2 = .086$. Similarly, the effect of time pressure on false control statement accuracy, $t(166) = 8.65$, $p < .001$, was stronger than the effect of time pressure on teleological test statement accuracy, $F(1, 166) = 8.96$, $p = .003$, $\eta\rho^2 = .051$. However, the effect of time pressure on teleological test statement accuracy was stronger than the effect of time pressure on true control statement accuracy, $t(166) = 1.86$, $p = .065$, and this comparison was statistically significant, $F(1, 166) = 20.66$, $p < .001$, $\eta\rho^2 = .111$.

3.2.4. Response Latencies

We next investigated response latencies for correctly rejected and incorrectly accepted teleological test statements. Following the same procedure as Study One, using only the un-speeded condition ($N = 119$), mean latencies were calculated separately for correctly and incorrectly answered teleological test statements for each participant. Standardised scores were computed based on these means, resulting the exclusion of four participants with z-scores greater than 4.25. All other z-scores were within a range of -0.75 to 2.13. Next, standardised scores were calculated for individual trials. Latencies for trials with a corresponding z-score greater than +/- 3 were replaced with the mean latency of either correctly or incorrectly answered trials. A further four participants were excluded for not having both correct and incorrect responses to the test statements, leaving 111 participants. A paired t-test revealed no significant difference in response latencies between correctly rejected ($M = 4812.52$, $SD = 1919.15$) and incorrectly accepted teleological test statements ($M = 4898.53$, $SD = 2386.45$), $t(110) = -0.43$, $p = .668$. A Bayesian paired t-test using an uninformative prior provided strong support for the null hypothesis of no difference between conditions ($BF_{10} = 0.077$).

As a more conservative test of the difference in response latencies between correctly rejected and incorrectly accepted teleological test statements, we restricted our analysis to statements with a mean accuracy of between 40% and 60%. As before, the paired t-test revealed no significant difference in response latencies between correctly rejected ($M = 4786.37$, $SD = 2559.61$) and incorrectly accepted teleological test statements ($M = 5110.01$, $SD = 3108.70$), $t(98) = -1.06$, $p = .293$. A Bayesian paired t-test using an uninfor-

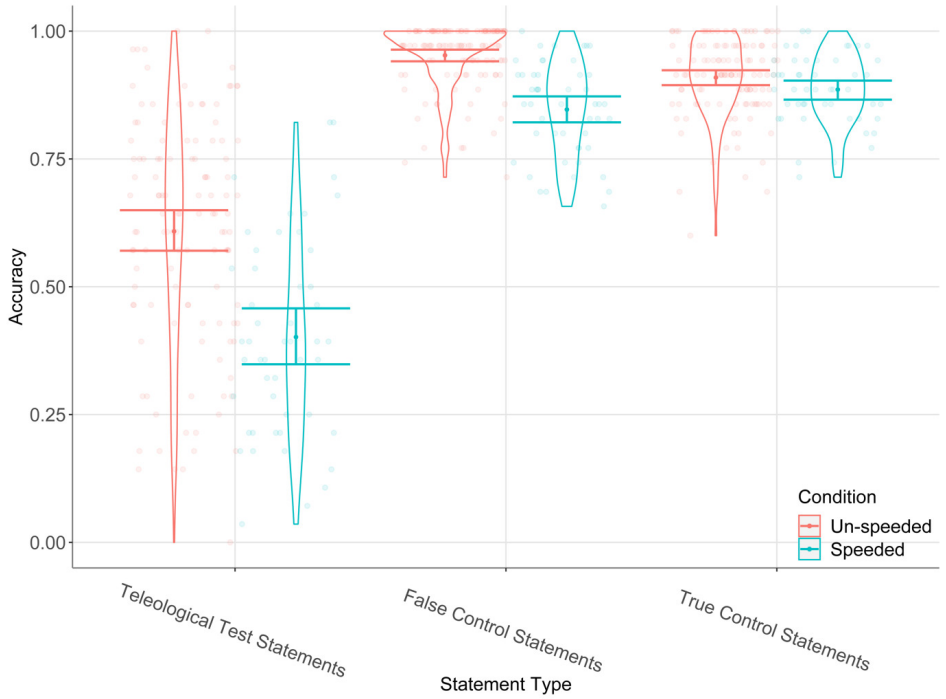

Figure 2. Mean Accuracy Across Statement-Types as a Function of Condition with Exclusion

Table 6. Accuracy for Statement Types as a Function of Condition after Participant Exclusion in Study Two

	Un-Speeded	Speeded	Difference	Effect (*d*)
Teleological Test	0.61 (0.23)	0.40 (0.19)	0.21 [0.13, 0.28]***	0.96 [0.60, 1.31]
Control Aggregate	0.93 (0.07)	0.87 (0.08)	0.06 [0.05, 0.08]***	1.29 [0.92, 1.66]
False Control	0.95 (0.06)	0.85 (0.09)	0.11 [0.08, 0.13]***	1.48 [1.09, 1.86]
True Control	0.91 (0.08)	0.89 (0.07)	0.02 [-0.001, 0.05]	0.32 [0.00, 0.65]

Note. Means are shown with standard deviations in parentheses. 95% confidence intervals are shown [L, U] for mean differences between conditions and for the effect size (Cohen's *d*) between conditions.
*** $p < .001$

mative prior provided strong support for the null hypothesis of no difference between conditions ($BF_{10} = 0.057$).[6]

3.3. Discussion

Using an undergraduate sample, Study Two replicated the key findings from Study One. First, rates of exclusion differed significantly between conditions, and participants who met the inclusion criteria were significantly better at inhibiting their intuitions compared to those who did not meet the inclusion criteria. Second, speeded decision-making had a greater effect on false control statement (in)accuracy than on teleological test statement (in)accuracy. Finally, replicating the findings from Study One, we found that response latencies for correctly rejected and incorrectly accepted teleological test statements did not differ.

4. General Discussion

The central claim of an intention-based theory of teleology, is that due to an early developing understanding that intentional agents have purposes, people have a developmentally persistent tendency to explain the world in terms of purpose and function (Kelemen, 1999a). While there is convergent non-experimental evidence to support this claim (e.g., Casler & Kelemen, 2008; Lombrozo et al., 2007; Zemla et al., 2012), experimental evidence comes from comparing rates of teleological acceptance in speeded and un-speeded conditions (e.g., Kelemen et al., 2013; Mills & Frowley, 2014; Roberts et al., 2020). Studies employing this paradigm have reported that by limiting the time available to reflect upon beliefs, participants show increased teleological acceptance relative to an un-speeded condition. This difference in teleological acceptance between

6 Without the replacement of outliers, the interpretation of response latency comparisons did not change. All statements, $t(115) = -0.06$, $p = .948$; only statements endorsed at moderate rates, $t(102) = 0.55$, $p = .583$.

conditions has been taken as evidence that adults have tacit teleological tendencies.

Consistent with theoretical (Kelemen, 1999a) and empirical work (Kelemen et al., 2013; Roberts et al., 2021; Willard et al., 2020; Willard & Norenzayan, 2013), we found that teleological beliefs about biological and non-biological natural entities were positively related to anthropomorphism and, in Study One, belief in God. Importantly, in both studies we found that teleological beliefs were negatively related to the tendency to inhibit intuitions. This is consistent with previous findings (Roberts et al., 2021; Zemla et al., 2012), and supports the view that an intention-based theory of teleology can be conceptualised within a dual-process framework. This dual-process perspective suggests that teleological beliefs about biological and non-biological natural entities represent a "developmentally persistent cognitive default" (Kelemen et al., 2013, p. 1075). Although teleological beliefs about biological and non-biological natural entities may be less frequently expressed by adults than by children, according to this view, such beliefs continue to have an intuitive appeal throughout adulthood.

Using both an online community sample and an undergraduate psychology student sample, the current studies identified several problems with the use of the speeded vs. un-speeded paradigm in the study of teleological beliefs. As this paradigm necessitates the exclusion of participants who respond inaccurately to control statements or fail to respond to a sufficient proportion of test statements within the time limit, this leads to different rates of exclusion between the conditions (Roberts et al., 2020). Exclusion was also found to vary systematically with the tendency to inhibit intuitions, with participants scoring lower on the Cognitive Reflection Test (CRT) more likely to be excluded. Due to the significantly higher rate of participant exclusion in the speeded condition than in the un-speeded condition, participants scoring lower on the CRT were disproportionately excluded in the speeded condition, but not in the un-speeded condition. As scores on the CRT were negatively related to rates of teleological acceptance, systematically excluding low-scoring CRT participants from the speeded condition means this paradigm may artificially decrease the mean rate of teleological acceptance in the speeded condition following participant exclusion. As a result, this paradigm may provide an overly conservative estimate of teleological acceptance in the speeded condition.

More problematic for research employing this paradigm in the study of teleological beliefs, is that the effect of time pressure on teleological acceptance, which has previously been taken as evidence of tacit teleological tendencies (e.g., Kelemen et al., 2013; Kelemen & Rosset, 2009; Mills & Frowley, 2014; Roberts et al., 2020), was weaker than the effect of time pressure on control statement (in)accuracy. That is, although the mean difference in accuracy between conditions was larger for teleological test statements than for control statements, the variation in accuracy for teleological test statements was also larger than for control statements. In both studies, the effect of time pressure for control statement inaccuracy was driven by responses to control statements that were objectively false. Rather than speeded decision-making uncovering tacit teleological tendencies, these findings suggest that speeded decision-making increases rates of acceptance for statements that are objectively false. Therefore, unless we are willing to concede that people implicitly believe that "post-it notes are sticky because they are yellow", or that "people smoke cigarettes in order to get lung cancer", it is problematic to claim that this paradigm provides evidence of tacit teleological tendencies.

While our results show that the speeded vs. un-speeded paradigm does not provide evidence for a dissociation of implicit and explicit teleological beliefs, in isolation, this would be considered a methodological issue, but not *necessarily* a theoretical one. That is, an intention-based theory of teleology suggests that teleological beliefs about biological and non-biological natural entities are a "developmentally persistent cognitive default" (Kelemen et al., 2013, p. 1075), but this theory does not rest on the claim that a speeded decision-making task can uncover such tendencies. However, the appropriateness of speeded decision-making in dissociating implicit and explicit teleological beliefs, is based on two theoretical assumptions. First, teleological beliefs are conceptualised as existing within a dual-process framework (Kelemen et al., 2013; Kelemen & Rosset, 2009; Zemla et al., 2012). According to this view, there exist two qualitatively different types of cognitive processes; type-1 processes which are fast, effortless, and do not require working memory, and type-2 processes which are slow, effortful, and do require working memory (e.g., Evans & Stanovich, 2013). In the current context, teleological beliefs are conceptualised as resulting from a type-1 process. According to this view, as speeded responding precludes the opportunity to engage in reflective thought, responses in the speeded condition are said to reflect a person's belief at an implicit level. Second, it is *implicitly* assumed that teleological and non-teleological beliefs about a given entity or phenomenon cannot coexist at a pre-reflective level and be held with equivalent conviction. The finding that response latencies did not differ between teleological statements that were correctly rejected and teleological statements that were incorrectly accepted, suggests that if this first assumption is true, and teleological beliefs do result from type-1 cognitive processes, the second assumption must be false.

Although non-experimental evidence suggests teleological beliefs are the default when alternative causal modes of explanation have not been obtained through formal education (Casler & Kelemen, 2008), or when alternative knowledge structures are impaired as a result of neurodegeneration (Lombrozo et al., 2007), this does not speak to whether the non-teleological beliefs of educated individuals without neurological impairment are merely "expressed", or whether they are held at a deeper "implicit" level. Recent work in the field of judgment and decision-making suggests that multiple automatic responses to a given stimulus can occur in parallel (De Neys, 2012, 2014; Pennycook et al., 2015). For example, people are intuitively aware of both the believability (Franssens & De Neys, 2009) and logical structure of arguments (Morsanyi & Handley, 2012; Trippas et

al., 2016), despite the fact that each of these factors may interfere with judgements of the other factor. People may hold implicit teleological beliefs about biological and non-biological natural entities, but if they also have an intuitive awareness of an alternative non-teleological explanation, time pressure would not necessarily lead to the expression of the teleological explanation over the alternative. Given the broader field of thinking and reasoning has moved towards dual-process models that allow for multiple type-1 processes to co-occur, theories that situate teleological beliefs within a dual-process framework should do the same. Future research should seek to test alternative paradigms that are not contingent upon the assumption that teleological and non-teleological beliefs about a particular entity cannot coexist implicitly and be held with equivalent conviction.

Drawing from the judgement and decision-making literature, one such alternative approach would be to make use of the belief bias effect. When asked to judge an argument as either logically valid or invalid, people are often biased by their belief in the conclusion of the argument (Pennycook et al., 2013, 2014). Specifically, when a logically valid argument contains an unbelievable conclusion, or when a logically invalid argument contains a believable conclusion, people experience a conflict between logical validity and belief, and are less accurate and slower to respond compared to when the logical validity and believability of the conclusion are congruent (Franssens & De Neys, 2009; Trémolière et al., 2014). By pairing teleological and non-teleological conclusions with both logically valid and logically invalid argument structures, it would be possible, based on an individual's stated beliefs, to determine whether they should experience a conflict for any given argument. Making use of the belief bias effect in this way, it may be possible to dissociate implicitly held and explicitly expressed teleological beliefs.

Although the current findings may seem inconsistent with the existing literature in showing that the speeded vs. un-speeded paradigm does not provide evidence of a dissociation of implicit and explicit teleological beliefs, many aspects of our work are consistent with the existing literature. First, the bivariate relationships between belief in God, anthropomorphism, inhibition of intuitions, and teleological acceptance replicate previous findings (Roberts et al., 2021; Willard et al., 2020; Willard & Norenzayan, 2013; Zemla et al., 2012). Second, in terms of the effect of time pressure on teleological test statements, the difference in accuracy between conditions (17% Study One; 21% Study Two) are similar to previously reported findings. In fact, the mean difference between conditions reported in previous studies (Kelemen et al., 2013; Roberts et al., 2020) are contained within the confidence intervals of the current results. In conjunction with the fact that the findings of Study One replicated when using a large undergraduate sample in Study Two, this provides additional confidence in the current results.

In summary, the current studies have shown that the standard experimental paradigm for demonstrating tacit teleological tendencies – to compare rates of teleological acceptance in an un-speeded condition to that in a speeded condition – may not, in fact, provide evidence for such tendencies. Rather, this paradigm results in selection bias and increased rates of acceptance for statements that are objectively false. This is more than just a methodological issue, as the use of speeded decision-making in this context is based on the theoretical assumption that teleological beliefs can be conceptualised within a dual-process framework. We have argued that for the dual-process perspective of teleological beliefs to accommodate the current results, a particular aspect of this view may need to be modified. Teleological beliefs about biological and nonbiological natural entities may well be a "developmentally persistent cognitive default" (Kelemen et al., 2013, p. 1075), but for adults who have learnt alternative mechanistic explanations, there is no reason why teleological beliefs could not coexist with their non-teleological alternatives at an implicit level. This reframing of the current dual-process perspective of teleology would not only align with recent theoretical and empirical work within the broader field of thinking and reasoning (e.g., De Neys, 2012, 2014; Franssens & De Neys, 2009; Morsanyi & Handley, 2012; Pennycook et al., 2015), but it would also inform new methodologies in the study of teleological beliefs. Speeded decision-making does not reveal tacit teleological tendencies, and this reframing of the dual-process perspective of teleology explains why.

Contributions

Conception and design: AJR, VP.
Acquisition of data: AJR.
Analysis and interpretation of data: AJR, SJH, VP
Drafted and/or revised the article: AJR, SJH, VP.
Approved the submitted version for publication: AJR, SJH, VP.

Competing Interest

We have no conflicts of interest to disclose.

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Data Accessibility Statement

Pre-registrations, data, and analysis code are stored on OSF (https://osf.io/pw7vm/).

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Supplementary Materials

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