The association between belief in free will, personal control, and life outcomes.

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A thesis submitted for the degree of Doctor of Philosophy

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December 2019

Acknowledgements

I would like to express my sincerest gratitude to my PhD supervisors Gethin Hughes, Mitchell J. Callan and Nicholas Cooper for their support and encouragement throughout my post-graduate studies. Specifically, I would like to offer massive thanks to Gethin Hughes for his considerable expertise and for being the first person to suggest to me that I would be capable of doing a PhD, without that comment I would still be working in a care home with no hope of a professional career. His positive impact on my future cannot be understated. Thanks to Mitch Callan for his considerable expertise on Social Psychology and his continued support with my thesis even after he ceased to be my supervisor. Thanks also to Nick Cooper for this expertise in TMS and his willingness to share it and for always being warm, approachable and supportive long before he became my supervisor. I am also grateful to the Economic and Social Research Council, who provided the funding that allowed me to undertake my PhD. Many thanks also to the staff at the University of Essex Psychology department including the academics who gave so generously of their time to answer my many questions and the all technicians and the admin staff who got me out of many a pickle. I must also thank my many friends in the department who were always these to support me in my moments of intellectual incontinence. Huge thanks to Katy my ever-tolerant wife and my sister Charlotte for their many hours of spell checking.

General abstract

The empirical investigation of free will beliefs is a fascinating and extensive field, offering potential insights into the extent and ramifications of free will beliefs, but this research is not without its limitations. Many competing definitions of free will exist. These competing definitions have informed the variety of free will manipulations and measures currently used, often without researchers properly addressing the important differences in the understandings of free will being operationalised, manipulated and measured. These manipulations and measures are also typically broad ranging, also including statements targeting determinism, reductionism and other related constructs. They therefore lack the focus necessary to identify just what aspect of these supposed free will manipulations are actually impacting cognitions, beliefs, and behaviours.

Across 7 studies we address some of these limitations. Study 1 confirms past findings demonstrating that perceptions of having choice and being free from constraints are central to lay understandings of free will. Study 1 also tests new single item measures of free will and determinism. In studies 2 and 3 we use our new measure of lay free will, to demonstrate that the previously established utility of free will beliefs for predicting subjective wellbeing, is due to the perceptions of having control that form the core of lay free will beliefs.

We then reason that, as pro deterministic/anti free will messages can undermine free will beliefs these manipulations may also impact perceived control and subsequently indicators of subjective wellbeing.

Studies 4 and 5 demonstrate that an abridged version of the Crick essay (typically used to undermine belief in free will), can undermine perceived control. This suggests that past successful manipulations of behaviour via the Crick essay, may have been due, at least in part, to reductions in perceived control rather than just free will beliefs.

The Crick essay is a broad ranging, poorly focused manipulation, simultaneously championing determinism while undermining the idea of free will. We therefore then endeavour to create two new, better focused, manipulations of free will/determinism, with reduced demand characteristics.

In study 6 our TMS manipulation lead to a significant reduction between participants' pre and post manipulation scores but this was also true for participants in the neutral condition. These complex findings are explored, suggesting that placing participants in an intimidating environment may undermine their perceptions of having free will.

In study 7 our deterministic video manipulation successfully undermines free will belief (compared to a non-deterministic video) but does not undermine perceived control or self-efficacy. These findings are explored further with participants' agreement with the deterministic or non-

deterministic video lecture, moderating the impact of condition on participants' ratings of free will, self-efficacy and perceived control. When compared to non-determinism, high agreement with determinism was associated with lower perceived control and free will belief. By contrast low agreement with determinism was associated with higher perceived control self-efficacy and free will.

In study 1 we created a new measure of cheating/dishonesty that can be used online. In study 7 we used this new measure of cheating and contrary to our predictions, exposure to a deterministic argument led to less cheating than exposure to a non-deterministic argument.

In the general discussion (chapter 9) the various strands of research are brought together and their contribution to the literature discussed. The limitations of our research are explored with new ideas proposed to address those limitations and further our work. Taken together, the research outlined in this thesis provides valuable new insight into the nature and implications of beliefs relating to free will and determinism, provides a valuable critique of research in this field and offers suggestions to improve and extend the current literature.

Overview of chapters

Chapter 1: An introduction to research into free will belief and its implications

In this chapter we outline the theoretical background to current research into free will belief and delineate the lines of research that this thesis will follow. 1) Attempted manipulations of belief in free will that seek to modulate socially relevant behaviours. 2) Lay definitions of free will and how those understandings contrast the more philosophically based definitions that often informs research 3) Research that explores free will beliefs by comparing them to other related concepts; in particular perceptions of possessing choice and control.

Chapter 2: Challenges, limitations and avenues for improvement

In this chapter we explore the limitations in methods and theory that currently frustrate research in the field of free will beliefs. We critique current manipulations and measures, highlighting replication issues relating to studies that target behaviour by undermining free will beliefs. Finally, strategies are identified that will address the aforementioned limitations and enhance our coming studies.

Chapter 3: Creating focused measures, a test of cheating and challenging the assumption that lay persons always see free will and determinism as incompatible

In this chapter we seek to lay the groundwork for the research to come. In Study 1 we confirm past research demonstrating that perceptions of possessing choice, in the face of external constraints, are at the heart of peoples' free will beliefs. We commence validation of our single item slider measures of free will and determinism. We challenge the assumption that participants always see free will and determinism as incompatible (a cornerstone of many current free will manipulations). Finally, we test a new measure of cheating by providing participants with an opportunity to skip a task by making a dishonest claim. This measure demonstrated good baseline levels.

Chapter 4: The association between believing in free will and subjective well-being Is confounded by a sense of personal control

In this published chapter we establish that peoples' sense of possessing choice and control underpin the relationship between free will beliefs and subjective wellbeing. Across studies 2 and 3 we demonstrate that free will beliefs do not predict indicators of subjective wellbeing beyond the contribution of the choice and control concepts that lay at the heart of lay understandings of free will.

Chapter 5: Manipulations designed to undermine belief in free will can also undermine perceived control.

In this chapter, we seek to establish a relationship between belief in free will/determinism and participants sense of possessing control. A paradigm standard manipulation of free will beliefs (the Crick essay) is tested. Although the full version of the Crick essay does not impact control beliefs related to possessing mastery and being free from constraints (study 4), a modified version of the Crick essay successfully undermines control beliefs relating to notions of having control over one's actions and decisions (study 5). This modified version of the Crick essay manipulation still retains some of the limitations of the original by lacking focus and directly mentioning free will. Clearly, we need to develop a more powerful, better focused yet implicit manipulation of belief in free will.

Chapter 6*: *Creating a new manipulation of free will beliefs and testing its effectiveness against the paradigm standard text-based approach.

In this chapter we outline study 6 in which we compared the Crick essay's capacity to undermine free will beliefs to our new manipulation that harnesses Transcranial Magnetic Stimulation (TMS) to target perceived free will by impacting participants' ability to execute a volitional action. Although the TMS manipulation is unsuccessful we explore research findings that hint at

the potential for TMS to undermine free will beliefs by making participants feel constrained. Participants' understandings of what the Crick essay means to them are probed. The findings demonstrate the unfocused nature of the Crick essay and highlighted its potential to induce demand characteristics.

Chapter 7: Belief in hard determinism and its impact on perceptions of free will, control self-efficacy and behaviour.

In this chapter we again endeavour to build a better manipulation, this time of deterministic beliefs. In study 7 we build upon studies 1-6, designing and testing pro-determinism and determinism-neutral video lectures. This new manipulation addresses many of the limitations of the stimuli typically used and successfully undermines belief in free will (despite never mentioning it). The impact of the manipulation on participants' perceived self-efficacy is explored and the crucial roles of demand characteristics and participant reactance are discussed. Surprisingly participants exposed to the non-deterministic lecture demonstrate significantly more cheating than participants exposed to the pro-deterministic lecture. Research broadly in line with this finding is discussed.

Chapter 8: General discussion

In our final chapter we combine and contextualize the findings from studies 1-7 and place them with within contemporary theoretical frameworks.

Future research is then proposed that will harness the deterministic video lectures we created for study 7 while better controlling for participant reactance, demand characteristics and affect.

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Chapter 1

An introduction to research into free will belief

The next two chapters will outline the key literature that investigates, manipulates and measures free will beliefs. Chapter one will provide an overview of the current literature. Chapter two will take the form of a critique that investigates some of the limitations and challenges that have hampered research in this field before outlining strategies for improvement. Our endeavours to implement those strategies will form the basis of the research in this thesis.

The effects of free will belief and its manipulation

We will begin with a brief overview of research that has attempted to experimentally manipulate belief in free will in order to either impact socially relevant behaviour or explore the neuroscientific markers of the psychological processes believed to underpin intentional action.

Belief in free will and its consequences has only become the subject of scientific inquiry in recent years. The majority of this research has focused on the experimental manipulation of free will beliefs. Typically, participants' free will beliefs are undermined via exposure to written texts or statements that refute traditional philosophical notions of free will, instead championing deterministic explanations for human thought and behaviour. The first study

to really capture the imagination of public and researchers alike was Vohs and Schooler's (2008) investigation into promoting cheating by reducing participants' belief in free will. Their methodology, described below, immediately became the standard.

In their first experiment Vohs and Schooler (2008) challenged the free will beliefs of participants by asking them to read 1 of 2 passages from Francis Crick's book 'The astonishing hypothesis' (Crick 1994), either an essay on determinism that refutes the existence of free will, or a passage on consciousness that did not mention free will. Participants' levels of free will belief (and related concepts) were measured via the freewill and determinism (FAD) scale (Paulhus & Margesson, 1994) (a 28 Item Likert measure) before an opportunity to cheat was presented in the form of a computer based maths test. Participants were told that the computer had developed a glitch causing the answers to the maths questions to also be displayed unless they corrected the glitch by pressing the space bar after each maths question was presented.

Participants exposed to the anti-free will essay pressed the space bar less often than participants who read the neutral text. This was interpreted by Vohs and Schooler (2008) as demonstrating higher levels of cheating in the anti free will condition. A strong negative correlation was observed with weaker endorsement of free will beliefs associated with more cheating. When free will beliefs and condition were entered simultaneously into a model predicting cheating, only free will beliefs emerged as a significant predictor;

suggesting that the manipulation had impacted cheating by modulating free will beliefs.

In their second experiment, Vohs and Schooler (2008) utilised a dependent measure that required active cheating. Free will beliefs were manipulated using a procedure adapted from Velten (1968) that required participants to read and consider 1 of 3 sets of 15 statements designed to either refute the existence of free will (determinism condition), endorse free will (pro free will condition) or avoid the subject entirely (neutral condition). A series of comprehension, logic and mathematical questions were then presented, and participants were able to claim money from a jar. The amount of money they were supposed to take was dependent on how many answers they claimed to have answered correctly. Efforts were made to ensure that the participants knew that their test results were anonymous. As such, participants knew that they could falsely take more money form the jar than they were entitled to. In other words they could cheat to take more money than they had earnt. Next participants completed the FAD scale (Paulhus & Margesson, 1994) as a manipulation checker and the PANAS (Watson, Clark & Tellegen, 1988) a measure of positive and negative affect, in order to rule out any confounding role for participants emotional reactions to the stimuli.

As predicted, participants' responses on the free will subscale of the FAD varied significantly according to the condition, with higher scores in the pro free will condition than the neutral condition and lower scores in the

determinism condition than the neutral condition. The experimental condition was also seen to influence cheating, such that overall participants in the deterministic condition claimed more monetary rewards. A strong negative correlation indicated that the more participants endorsed free will the less they paid themselves. A subsequent ANCOVA was conducted with free will beliefs and condition entered simultaneously into the model as predictors of cheating. Condition failed to uniquely predict cheating behaviour whereas free will beliefs were uniquely associated with increased cheating. Changes in participants' emotional state were not found to have driven these results.

This initial research was soon built upon and the impact of deterministic stimuli explored in relation to other socially relevant behaviours. For example, Baumeister (2009) applied the statement reading task developed by Vohs and Schooler (2008), finding that participants exposed to these anti free will messages displayed a reduced willingness to help hypothetical people in need, when compared to participants exposed to neutral and pro free will statements. In a follow up study, participants exposed to the deterministic statements displayed more aggression in the form of requiring a confederate to eat more of a hot salsa.

Other behaviours were identified as susceptible to text-based manipulations of free will belief. Experimentally diminishing free will beliefs has reduced the amount of retributive punishment participants believed that a hypothetical murderer should receive (Shariff, Greene, Karremans, Luguri,

Clark, Schooler & Vohs, 2014) and reduced both gratitude for a favour and the perception that one's benefactor was motivated by a sincere intention to provide help. In other research, belief that a benefactor was free to choose increased the evaluation of the benefactor's perceived motivational sincerity and this in turn increased the gratitude experienced (MacKenzie, Vohs, & Baumeister, 2014). This finding suggests that an actor's perceived capacity for choice is fundamental to ascriptions of free will beliefs.

Challenging FWB via deterministic stimuli has increased racial prejudice (Zhao, Liu, Zhang, Shi & Huang, 2014), reduced intuitive cooperation (in some circumstances) (Protzko, Ouimette & Schooler, 2015). Belief in free will may even have links to learning from past misdeeds. Stillman (2010) found that participants exposed to the deterministic stimuli claimed to have learned less from a past misdeed than participants in neutral or pro free will conditions. However, this effect was only apparent for those participants reporting high levels of guilt for the misdeed.

In one variant on the Velten (1968) style manipulation, introduced by Vohs and Schooler (2008), participants were asked to both read and rewrite a series of statements that are either pro free will, anti free will/deterministic or neutral. Compared to reading and re writing pro free statements, reading and re writing deterministic statements caused people to conform more, by copying others' ratings of artworks and product names, rather than generating their own as instructed (Alquist, Ainsworth, & Baumeister, 2013).

It has not always been a reduction in free will beliefs that has driven changes in cognitions and behaviours. For example, participants induced to believe more in free will have been shown to generate more counterfactual thoughts about how they could have done things differently, after first being asked to introspect about a past incident in which they had hurt someone (Alquist, Ainsworth, Baumeister, Daly, & Stillman, 2014)

Findings at the Neuroscientific and cognitive levels

The research outlined so far in this chapter has explored the impact of text based free will challenges on peoples' moral behaviour and evaluations of others' morally relevant behaviours. Those behavioural level findings have been complimented by research exploring the impact of text based free will challenges at the neuroscientific and cognitive levels, more specifically on the neural and cognitive markers of the psychological processes believed to represent intentional action.

Rigoni and Colleagues (Rigoni, Kühn, Sartori & Brass, 2011; Rigoni, Kühn, Gaudino, Sartori & Brass, 2012; Rigoni, Wilquin, Brass & Burle, 2013) explored the notion that challenging an individual's belief in free will reduces their belief that they can control their own behaviour, this in turn reduces their intentional involvement with tasks. This task disengagement is not general but specific in nature. Evidence for this has come from a series of studies that highlighted the impact that deterministic free will challenges can have on, for instance, the early RP (readiness potential), a correlate of

conscious motor preparation believed to be modulated by levels of intentional involvement (Rigoni et al., 2011). In other work, these free will challenges have been shown to impact self-control in the form of intentional motor inhibition (Rigoni et al., 2012) and action adjustment after an error (Rigoni et al., 2013). The involvement of a person's implicit sense of agency, their feelings of having causal ownership of their actions and subsequent outcomes has also proven susceptible to these manipulations (Lynn, Muhle-Karbe, Aarts, & Brass, 2014). The influence of these high-level beliefs have been shown to impact self-regulatory engagement during a thermal pain stimulation experiment with participants induced to disbelieve in freewill slower to act to terminate pain stimuli (Lynn, Van Dessel & Brass, 2013).

Defining and understanding the concept

The work so far highlights the effects that challenging free will belief can have on socially relevant behaviours and some of the neuroscientific and cognitive markers of the processes that may underpin them. But what is free will? What is the concept of free will that lay participants hold? Is it the same concept that researchers operationalise and manipulate? In other words, what concept of free will is actually being challenged in these experimental manipulations? Amongst researchers and thinkers, multiple understandings of free will exist and different traditions and disciplines have their own unique take on how free will should be conceptualised (see Bargh, 2008). Definitions drawn from the philosophical tradition, typically define free will in a manner that privileges

human consciousness (or the soul) as the true source of decision making and thought (Cashmore, 2010; Descartes & Lafleur, 1960; Harris, 2012; Montague, 2008). Under such an account, for free will to exist our consciousness must be distinct from our physical brain, able to act as a first mover, making choices without initiation or influence from prior events and demonstrating immunity from the causal laws that govern the rest of the physical universe.

Understanding what is being measured and manipulated in the studies described above requires that we first understand what the lay concept of free will is.

Monroe and Malle (2010) attempted to explore laypersons' definitions of free will by directly asking undergraduate students to *"please explain in a few lines what you think it means to have free will."* This direct referencing of free will by Monroe and Malle (2010) is important, because, as we will discuss in the next chapter, free will's vague and contested nature has often required researchers in this field to utilise stimuli that either (1) directly reference free will, (2) risk tapping into related/overlapping concepts or (3) impose the researches own definitions on the concept.

The free will definitions that emerged from their participants' qualitative responses were almost entirely psychologically based, representing an understanding of free will as a choice that fulfils one's desires and is free from internal or external constraints. Monroe and Malle (2010) were able to identify few if any even vague references to philosophical notions of non-

physical souls or non-deterministic causation. This finding was supported by a community sample of older participants that identified much the same pattern of definitions but with an added dimension of planning for the future (Monroe & Malle, 2014). Monroe, Dillon and Malle (2014) demonstrated that free will ascriptions around moral responsibility were largely understood by their participants as a capacity for intentionality, choice and being the sole cause of an action, with only a small contribution from notions of a soul. This notion of a soul also broke apart from free will ascriptions when participants were asked about the volitional capacities of a range of hypothetical agents. The overarching conclusion from these studies is that laypersons' understandings of free will are based on psychological concepts with little if any input from the metaphysical free will definitions rooted in the philosophical tradition. This is fortunate as a form of free will that possess the capacity to thwart causality would have proven fiendishly difficult to investigate via empirical methods reliant on the exploitation of causal relationships.

Free will beliefs and their relationship to other concepts

We will turn now to research conducted at a broader social level, typically exploiting correlational and qualitative methods to examine how free will can be understood in terms of its relationships to other concepts. Belief in free will appears to be something that is found across human cultures (Sarkissian et al., 2010), is enduring, often surviving even in environments where physical

freedom, personal autonomy and meaningful choice are purposefully constrained (Laurene, Rakos, Tisak, Robichaud & Horvath, 2011). Free will is associated with conscious thinking (Sheperd, 2012), generating counterfactual understandings (Alquist et., 2014) and when explored in an autobiographical narrative, linked to moral behaviour, achieving goals, high levels of conscious thought, deliberation and positive outcomes (Stillman, Baumeister & Mele, 2011). Possessing a belief in free will has also been linked to positive life outcomes in the form of higher self-reported life satisfaction, meaning in life and subjective happiness and reduced negative indicators in the form of lower levels of perceived life stress (Crescioni, Baumeister, Ainsworth & Lambert, 2015; li et al ., 2017).

Free will beliefs can also contribute to an individuals' sense of expecting to achieve positive outcomes. Free will beliefs were associated with student participants self-reported expected career success, doing so independently of and to a greater extent than locus of control (Stillman, Baumeister, Vohs, Lambert, Fincham & Brewer, 2010). This relationship went beyond self-reported expectations of success, however, with agency workers who endorsed belief in free will, evaluated more favourably by their supervisors in terms of work effort, consistency in showing up for work and their positive social impact on fellow workers. The researchers interpreted this as free will beliefs facilitating individuals in exerting control over their actions. More recently Feldman, Chandrashekar and Wong (2016) linked belief in free

will to academic performance. Higher FWB predicted better performance on an academic proofreading task and, in a separate study, higher free will belief measured at the beginning of an academic semester predicted better grades at its completion. Free will beliefs had a greater capacity to predict participants' academic performance, than their trait self-control (participants perceived ability to resist temptation and exercise self-control) and their implicit theories (their belief about others capacity for change (Feldman et al., 2016).

The concept of free will is strongly linked to notions of moral accountability,

correlating positively with attitudes toward punishment as a form of deterrence, rehabilitation and retribution (Rakos, Laurene, Skala & Slane, 2008). Researches have also attempted to isolate participants' retributive evaluations and study their relationship to free will beliefs. Shariff et al. (2014) found that pre-existing free will beliefs were associated with retributive rather than consequentialist responses to crimes. In another study, attending neuroscience classes (presumed to be a source of deterministic thinking) resulted in reduced ratings of retributive punishment for a hypothetical offender. Experimentally undermining belief in free will also reduced the level of retributive punishment that participants believed a hypothetical offender deserved. Similarly, Krueger, Hoffman, Walter and Grafman (2014) found that free will believers rated a hypothetical offender as deserving more

punishment than determinists but only for low affect crimes. This suggests that when crimes are serious and emotions run hot, the impulse to punish may be too strong to be impacted by deterministic beliefs. However that may not be the case when the deterministic explanation is specifically linked to the offender.

Carey and Paulhus (2013) explored the link between blame and free will belief in regard to a high affect crime in the form of a child molester scenario. Although higher belief in free will was associated with higher punitive evaluations, hearing about the offenders' abusive childhood and current mental health challenges (deterministic conceptualisations relevant to mental processes and perceived choice capacity) significantly reduced participants' punitive evaluations. Others have explored the impact of immoral behaviour on free will belief. Reading about the moral breaches of others has been shown to increase free will belief, mediated by the desire to punish.(Clark, Luguri, Ditto, Knobe, Shariff & Baumeister, 2014). However, it is likely that the link between blame and free will beliefs draws less upon free will beliefs per se and more on the evaluations of the agents choice capacity and intentionally (Monroe, Dillon & Malle, 2014; Monroe, Brady & Malle 2017)

Free will belief and choice

Perceived choice capacity appears to be at the heart of lay concept of free will (Monroe & Malle, 2010; 2014) and of many instruments designed to measure free will beliefs (Paulhus & Carey, 2011; Rakos, Laurene, Skala & Slane, 2008). Feldman, Baumeister and Wong (2014) explored the link between free will and choosing, finding that participant's that expressed greater belief in free will reported a greater preference for making choices and perceived themselves to be better at choosing. In a second study participants were asked to introspect on past activities (such as purchasing electronics), where they had to decide on an option. Participants that endorsed free will beliefs more strongly, were more likely to perceive actions that involve selecting between options, as involving choice, to perceive these selection/choices as less difficult, and to report that they were more satisfied with their selection. In a third study Feldman et al. (2014) asked participants to either recall actions or list choices and decisions made during the previous day. The participants asked to list choices reported higher levels of free will belief. In the final study, participants conducted a series of trials. They were sorted into either a high choice condition (choosing between 4 pens), a low choice condition (choosing between 2 pens), one of two action conditions, or a control condition (in which participants were asked questions about yesterday's weather). Participants' belief in free will in general was higher in the two choice conditions than in the control condition. In terms of belief in personal free will

this relationship was only significant for participants in the high choice condition.

Overall then perceptions and cognitions regarding choice lay at the heart of understanding of free will.

Free will belief and the experience of control

The experience of successfully executing choices would be expected to go hand in hand with a feeling of control, after all what is control but the successful execution of choices? Experimentally increasing belief in free will has been shown to increase the amount and meaningfulness of goal-directed content provided by participants during a task in which they were asked to describe things that they would like to do Crescioni et al. (2015). Similarly, Stillman, Baumeister and Mele (2011) asked participants to generate autobiographical accounts of actions that they deemed to be either of, or not of, their own free will. The participants in the free will condition generated more accounts consistent with their long-term self-interest and goal attainment. The link between free will beliefs and the goal acquisition is further supported by Crescioni et al. (2015) finding that free will beliefs correlate with perceived self-efficacy, a construct that probes and individuals' perceptions that they are able to meet challenges and achieve goals across a variety of situations. Free will beliefs appear to be associated with goal acquisition a concept conceptually close to sense of control.

Despite this apparent overlap between sense of control and free will, some previous research has shown that free will belief has predictive utility beyond an individual's sense of control at least when control is measured in terms of participants perceived locus of control (Rotter 1966), Locus of control (Rotter 1966), describes the degree to which the individual believes that they (internal locus of control), rather than outside forces (external locus of control), possess control over their life's outcomes. Stillman et al. (2010) explored the relative contribution of free will belief and locus of control for predicting expected future job performance. Although both free will belief and Locus of control were able to predict expected future job performance, free will beliefs had predictive power over and above the contribution of locus of control. Paulhus and Carey (2011) found that their free will sub-scale correlated strongly but not so strongly as to suggest that both measures draw on the same concept. They concluded that locus of control and free will are related but distinct concepts. So Free will beliefs are similar to beliefs about locus of control yet distinct; more effective at predicting things like life satisfaction than locus of control. Similarly Crescioni et al. (2015) outlined the unique contribution that free will beliefs have above and beyond that of implicit person theory and locus of control (via Duttweiler's (1984) internal control index), for predicting life satisfaction, gratitude, self-efficacy and meaning in life. Taken together, these studies suggest that the concept of free

will is closely related to the concept of locus of control but possesses unique utility to predict a range of important life outcomes.

It seems reasonable to conclude that free will beliefs overlap with but are not identical to possessing an internal locus of control. Free will belief's dimension of possessing choice capacity and freedom from constraints (Monroe & Malle, 2010) seems like a likely candidate for this potential overlap.

The evidence described above shows that sense of control seems to correlates strongly with free will belief. Other research has suggesting that manipulating sense of control, by invoking involuntary actions, can have a causal impact on free will beliefs. (Ent, 2013) evoked involuntary eye blink responses from participants' by directing puffs of air into their eyes with a bulb syringe. The researcher then triggered the pupillary reflexes of these participants by shining a penlight on the outside corner of each eye, then in between the eyes. These participants subsequently reported lower belief in free will than participants who simply executed a voluntary response by bouncing a ball between their dominant and non-dominant hands. This suggests that evoking involuntary movements in people, threatens their belief in free will. Interestingly, this relationship was only observed for individuals low in trait reactance. Reactance (Brehm 1966; Miron & Brehm, 2006) is a person's drive to resist perceived threats to their sense of being a free agent, able to behave as they choose. As such, Ent (2013) showed that only

individuals that were more willing to accept a threat to their sense of control, were influenced by the involuntary actions.

Similar evidence for the role of bodily control in free will belief comes from investigating individuals who suffer from involuntary seizures. Ent and Baumeister (2014) identified reduced belief in general free will for people with epilepsy and panic disorders, two conditions associated with reduced bodily control. In terms of evaluations of the participants' personal free will, this effect was close to significant for those with epilepsy ($p=.053$) but not significant for individuals with panic disorders. In a second study the researchers attempted to link temporary bodily states to perceptions of free will. They reasoned that bodily demands in the form of hunger, thirst, tiredness, need to urinate and sexual desire might remind the individual that they lack complete control over their bodies, undermining their sense of possessing free will. People's belief in their personal free will negatively correlated with their need to urinate, their sexual desire and their physical tiredness but no significant relationship was found with their level of thirst or hunger. A follow up study was conducted to probe the reason for the failure to observe a relationship between free will belief and hunger. An interaction was observed whereby hunger predicted reduced belief in personal free will but only for non-dieters. The researchers argued that for non-dieters, hunger acts like the other bodily needs (outlined above) reducing participants perceptions of having control and there subsequent sense of personal free

will. For dieters feelings of hunger may become associated with the feeling of exerting their free will over their bodily needs (Ent & Baumeister, 2014). This complex set of results suggests that an individual's understanding of their personal free will may also draw upon their sense of possessing control over their bodies.

Chapter Summary

Manipulating belief in free will can impact socially relevant cognitions, behaviours and some of the neural and cognitive markers of intentional action. Complicated free will definitions, drawn from the philosophical tradition, have been contrasted by more down to earth lay understandings. Belief in free will is widespread and linked to evaluations of moral responsibility, blame and a range of important life outcomes: most likely due to its close relationship to evaluations/perceptions of choice and control. The scientific investigation of free will beliefs has produced a large and fascinating literature. However, challenges have arisen. The nature of these challenges and how best to tackle them, will be the subject of our next chapter.

Chapter 2

Challenges, limitations and avenues for improvement

Chapter one outlined current research into the nature of free will beliefs and its consequences. This chapter will explore some of the limitations and challenges that have emerged in the field. We will offer strategies to address these limitations and challenges and by doing so, lay out the main aims of this research project.

Replication issues

No area of research is without difficulties. The most significant challenges have arisen in the line of research that seeks to manipulate FWB in order to influence socially relevant behaviour. Baumeister and Monroe (2014) have outlined their failed attempts to successfully replicate Shariff et al's, (2014) finding that deterministic messages reduce participants' inclinations for retributive punishment. Replication issues also struck at the foundation of this field when Giner-Sorolla, Embley and Johnson (2015) failed to replicate the Vohs and Schooler (2008) study that first reported elevated cheating after an anti free will manipulation. Although some attempts to induce cheating by manipulating free will beliefs have been successful (for an example see Trager, 2013), other researchers have failed to manipulate cheating behaviour (van

den Brink, 2016; Nadelhoffer, Shepard, Crone, Everett, Earp & Levy, 2019) when using methods similar to those reported by Vohs and Schooler (2008). Indeed, Schooler, Nadelhoffer, Nahmias and Vohs (2014) have themselves reported difficulties with consistently manipulating behaviours via deterministic anti free will messages during their attempts to produce more finely focused and reliable stimuli. Schooler et al. (2014) concluded that strong and multi-faceted manipulations of free will (like the Crick essay) may be necessary to modulate belief and behaviour.

Consistent replications have not been forthcoming and after an initial flourish of successful studies, further extensions to the original findings have slowed to a crawl. This must be seen as problematic for research that manipulates high level beliefs about free will and determinism in order to influence socially relevant behaviour. In response to the failed replications, Schooler et al. (2014) have pointed out that in their original study (Vohs and Schooler, 2008) they used, but failed to report, presenting the text based free will manipulations and dependent measures to their participants as two completely separate pieces of research. Schooler et al. (2014) conducted a series of studies intended to replicate the original findings of Vohs and Schooler (2008) and create better focused experimental manipulations. In one of these studies they tested the effectiveness of framing effects by either presenting the manipulation and dependent measures to participants as part of the same study or presenting them as parts of two separate studies.

Schooler et al. (2014) found that the Crick essay was only able to impact participants' ratings of free will belief and locus of control, when the manipulation and dependent measures were presented separately. However, they did not successfully manipulate cheating behaviour in that study even when framing the manipulation and depended measures as parts of separate studies. There finding provides some support for the argument that framing effects can enhance the strength of the manipulation but only in terms of its impact on self-reported free will beliefs and locus of control.

This work appears to have been conducted prior to Giner-Sorolla et al's, (2015) failed replication of Vohs and Schooler (2008). Giner-Sorolla et al. (2015) were likely unaware that Vohs and Schooler (2008) had harnessed this framing effect by presenting their manipulation and depended measures as parts of separate studies. It could be argued that the lack of framing effects contributed to Giner-Sorolla et al's. (2015) failure to replicate Vohs and Schooler (2008). However, Nadelhoffer et al's. (2019) attempted replication of Vohs and Schooler (2008) also failed to successfully evoke cheating behaviour by manipulating free will beliefs despite including framing effects by presenting the manipulation and dependent measures as part of two separate studies. Nadelhoffer et al. (2019) conducted their manipulation online rather than in the lab as with Vohs and Schooler (2008) and it may be that the attempt to frame the manipulation and dependent measures as parts of separate studies, was far less convincing when conducted online. As

mentioned above Schooler et al. (2014) concluded that multiple factors may be necessary to successfully manipulate belief in free will and impact behaviour. These factors include framing effects and strong and multi-faceted manipulations. However, broad ranging, multi-faceted manipulations, may introduce as many issues as they solve.

Broad unfocused Manipulators

In chapter one we outlined the study by (Vohs, & Schooler, 2008) that introduced the (Crick, 1995) and Velten (1968) style manipulations. These manipulations have since been used in the majority of studies that have attempted to manipulate free will belief, attitudes, cognitions and behaviours. Despite replication issues described above, the Crick essay manipulation has since been used successfully in many studies (Lynn, et al., 2014; MacKenzie et al., 2014; Rigoni et al ., 2011; Rigoni et al., 2013; Vohs & Schooler, 2008). However, Rigoni, and Brass (2014), amongst others, have pointed out that these stimuli are broad ranging, potentially manipulating a variety of concepts related to free will. For example, the passages taken from Crick (1995) include arguments likely to enhance belief in neuro reductionist thinking, evolution and scientific determinism, while simultaneously challenging potentially precious beliefs regarding religion, the soul, the afterlife and participants' perceived capacity for choice. Crick presents complex concepts often using low frequency words that may intimidate or disinterest participants, especially

when Crick implies that to disagree with him demonstrates a lack of education. Below are examples taken from the Crick essay.

> *"In addition to scientists, many educated people also share the belief that the soul is a metaphor and that there is no personal life either before conception or after death"*
>
> *"You," your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behaviour of a vast assembly of nerve cells and their associated molecules. Who you are is nothing but a pack of neurons.*
>
> *"So, although we appear to have free will, in fact, our choices have already been predetermined for us and we cannot change that".*
>
> *Francis Crick. A Postscript on Free Will (1995)*

The Velten (1968) style manipulation is the most widely used FWB manipulation (Alquist, Ainsworth & Baumeister, 2013; Baumeister, Masicampo & DeWall, 2009; Rigoni, Kühn, Gaudino, Sartori & Brass, 2012;

Vohs & Schooler, 2008; Crescioni, Baumeister, Ainsworth, Ent, & Lambert, 2016; Stillman & Baumeister, 2010; Schrag, Tremea, Lagger Ohana & Mohr, 2016; Monroe, Brady & Malle, 2017) and is equally broad ranging. The Velten (1968) style manipulation consists of 3 conditions each containing 15 statements that participants are required to read, consider and on some occasions rewrite in their own words.

The determinism condition is comprised of 4 statements attacking the idea of free will (e.g "science has demonstrated that free will is an illusion") and 11 statements encouraging belief in scientific determinism (e.g Every action that a person takes is caused by a specific pattern of neural firings in the brain), 7 of which reference biological determinants, neurons, biology, genetics etc.

In the pro freewill condition 4 statements encourage free will belief (e.g "I demonstrate my free will every day when I make decisions", 5 act to lower belief in scientific determinism (e.g "our actions and thoughts are not simply the result of prior experiences".) and 5 statements encourage moral responsibility (e.g I have feelings of regret when I make bad decisions because I know that ultimately I am responsible for my actions"). Additionally, 1 statement references control.

In addition to manipulating a broad range of different concepts, both the Crick essay and Veltan manipulators carry with them substantial demand characteristics by openly stating that free will does not exist and (in the case

of the Crick essay) by suggesting that this is the position that well educated people adopt.

Broad unfocused Measures

The breadth of the current manipulators is matched by the breadth of the tools designed to measure free will beliefs, both as manipulation checkers and in correlational research. For example, the free will subscale of the FAD-Plus (Paulhus & Carey, 2011) contains 7 sentences, 2 affirming personal control, 1 affirming control over life goals, 3 suggesting that individuals are morally responsible for their misdeeds and 1 claiming that people have free will. Given that the free will subscale is comprised predominantly of items referencing moral responsibility, with only a single item referencing free will, it is hardly surprising that this subscale correlates strongly with participants' punitive judgements in response to a child molester scenario (Carey & Paulhus, 2013).

The Free Will and Determinism Scale (Rakos, Laurene, Skala & Slane, 2008) has 22 items spread over its general free will and personal free will subscales. Of those items 4 refer to the control of a higher power 6 refer to free will, 6 refer to moral responsibility and 6 address matters of choice and decision making.

Both the FAD-Plus and the Free Will and Determinism scale include items that tap concepts of choice and control. Perceived freedom to choose is one of the core constituents of free will as defined by many in the philosophical tradition and also maps well onto the lay definition of free will

that sees choice capacity as a key component (Monroe & Malle, 2010). We suspect that it is this core component of choice that drives many of the findings that sees free will beliefs predict indicators of subjective wellbeing (Crescioni et al., 2015) and important life outcomes like job performance (Stillman et al., 2010). The role of perceived choice as the central component of lay understandings of free will and the component that may predict subjective wellbeing, deserves further exploration.

The assumption of lay incompatibility

The broad ranging and multi-faceted nature of the manipulators and measures outlined over the previous paragraphs are typical of manipulations and measures currently used in the field of Free will research. One reason for the breadth of the manipulations and measures appears to be their creator's decision to draw upon understandings of free will and determinism form philosophical approaches. Although perfectly legitimate, this approach has consequences for the nature and breadth of the concepts probed, adding elements of moral responsibility to free will subscales and informing the nature of the other subscales against which the fee will subscale will be contrasted. Further adding to the breadth of current manipulations is their creator's assumption that laypersons consistently and reliably embrace an incompatibilist understanding of free will. That is to say that lay participants always view belief in free will and belief in scientific determinism as opposite

ends of a single continuum, meaning that increasing belief in determiism is conceptually identical to decreasing belief in free will.

Within Condition incompatibilism

This has led to widely used manipulations (e.g Crick essay and Velten statements) containing both anti free will and pro determinism statements in the same experimental condition. In other words, the anti free will conditions contain both statements championing scientific determinism and statements that denying the existence of free will. As a result of this conceptual casserole it becomes impossible to discern whether free will or determinism (or both) was manipulated, and therefore, what produced any observed modulation of the dependent measures. Of course, it is entirely plausible that the anti-free will and pro deterministic statements may be consolidated in the minds of participants, combining to form a single attack on their perceived choice capacity, but consistent reliable lay incompatibility has yet to be established empirically. Indeed, researcher's have found that Lay participants do not always see free will and determinism as incompatible (Nahmias, Morris, Nadelhoffer & Turner, 2006; Nichols, 2006; Nichols & Knobe, 2007; Murray & Nahmias, 2014; Shepherd, 2012).

Implications of assuming lay incompatibility when combining subscales

The assumption of lay incompatibility can become compounded in studies that use measures of scientific determinism to gauge the impact of an anti

free will manipulation (see, e.g., Stillman & Baumeister, 2010) but becomes particularly problematic when researchers take the separate subscales from a given instrument and combine them to create a supposed 'global' measure of free will (or intentional control). This strategy typically involves reverse scoring the Free Will subscale of the FAD-Plus (Paulhus & Carey, 2011) and combining it with the other three subscales (Scientific Determinism, Fatalistic Determinism, and Unpredictability) (see Lynn, Van Dessel & Brass, 2013; Rigoni, Wilquin, Brass & Burle, 2013 for examples). Similar reversal and aggregation strategies have been employed with other measures of free will beliefs (Genschow, Rigoni & Brass, 2017).

The assumption of lay incompatibilism behind these strategies can be convincingly challenged. The creators of the FAD-Plus in particular went to great lengths to demonstrate the independence of their free will and scientific determinism subscales. Paulhus and Carey (2011), over multiple rounds of testing demonstrated that their free will and scientific determinism items loaded consistently onto different subscales. These subscales demonstrated no reliable positive or negative relationships. The makers of the free will inventory did not come to a definitive conclusion about lay incompatibilism but did not find that their free will and determinism subscales correlated significantly (Nadelhoffer, Shepard, Nahmias, Sripada & Ross, 2014). Independently, Feldman et al. (2014) did not report a statistically significant correlation between the Scientific determinism subscale of the FAD-Plus

(Paulhus & Carey, 2011) and the FW subscale of the FAD-Plus (r = 0) the Scientific determinism subscale of the FAD-Plus also failed to correlate significantly with either the General free will subscale (r= -.12), or the Personal free will subscale (r= -.14), of the FWD (Rakos, 2008).The idea that an increase in free will beliefs is conceptually identical to a decrease in scientific determinism is not supportable for these measures.

Summary

Replication issues have plagued the area of free will research that seeks to influence socially relevant behaviour by modulating belief in free will and determinism. Schooler et al. (2014) conducted a number of studies aimed at separating out and focusing the different influences inherent in their stimuli. It was hoped that this would allow for the specific influence responsible for impacting moral behaviour, to be identified (if indeed one exists). This work met with little success and Schooler et al. (2014) concluded that high impact, broad ranging stimuli may be essential for the successful manipulation of free will beliefs and subsequent behaviour. However, we argue that broad ranging stimuli (born of philosophical understandings of free will) present considerable challenges in terms of identifying what constituent actually impacted behaviour. The use of broad ranging post manipulation measures of free will and determinism further compounds this issue especially when assumptions of lay incompatibility lead to their improper use. These multi-faceted broad and unfocused measures and manipulations are scattergun

instruments that proved invaluable during the initial stages of theory development. These instruments now lack the precision to untangle the interactions, overlaps and conflations between primary aspects of free will belief, like choice capacity (Monroe & Malle, 2010), from probable secondary phenomena, like gratitude, most likely predicated on evaluations of the benefactors' choice capacity and subsequent motivational sincerity (MacKenzie et al., 2014). Only once these primary and secondary influences of FWB are understood can the long term relationship between FWB and life outcomes, like academic performance (Feldman et al., 2016), be properly understood and exploited.

Key research aims

A number of opportunities to develop the field have emerged from our analysis of the research literature. Our key aims are as follows:

1. The lack of conceptual focus inherent to many current measures of free will belief requires us to develop and use more focused single item measures of free will and determinism. These measures will need to target only participants belief in a single concept and indeed Feldman (2016) and McKenzie (2014) have already successfully used single item measures of free will beliefs.

2. This research project will test the validity of the assumption of lay incompatibility for any new measures/manipulators in order to understand the full extent of their breadth. This may also help us understand the true implications and limitations of past research.

3. This research project will explore the overlap between free will beliefs and the related and potentially underlying concepts of choice and control. We will explore whether it is in fact these core elements that underlie the relationship between free will beliefs and indicators of subjective wellbeing. We will go onto explore whether the manipulation of choice and control (encapsulated within understandings of determinism) provides a better avenue for the fruitful investigation of life outcomes.

4. Replication issues combined with the problems encountered when attempting to reduce manipulator breadth Schooler et al. (2014) and the lack of focus inherent in the current FW measurement scales, all present considerable challenges. This research project will develop more targeted stimuli that includes only the conceptually relevant aspects of the Crick manipulation and that encapsulates contemporary deterministic arguments, while reducing demand characteristics.

The research conducted to achieve these key aims will be presented in the next 5 experimental chapters.

Chapter 3

Study 1

Creating focused measures, a test of cheating and challenging the assumption that lay personals always see free will and determinism as incompatible

Abstract

Most manipulations and dependent measures used in free will research were constructed assuming that lay participants see free will and determinism as incompatible. Manipulations are typically broad ranging and multi-faceted, mapping poorly onto the free will concepts of lay participants.

This study elicited lay participants qualitative free will definitions and gauged their belief in free will and scientific determinism via well validated multi item measures and our new, more focused single item measures. We then presented participants with an opportunity to cheat by falsely claiming to have heard of a fictional organisation thus saving themselves from a short writing task.

Our results were in line with past findings (Feldman et al., 2014), demonstrating that, lay participants do not necessarily see free will and determinism as incompatible.

Our attempt to offer initial validation for our new more focused single item measures of free will and scientific determinism was successful. Participants free will definitions were broadly in line with those observed by Monroe and Malle, (2010) focusing on choice capacity and freedom from constraints. Our attempt to predict cheating behaviour from participants free will beliefs was unsuccessful due to an error with data collection, but we established good baseline cheating levels for our new online cheating measure.

Introduction

As discussed in the introduction, the scientific investigation of free will beliefs can be delineated into two main fields. The first is correlation based and measures participants' free will beliefs in order to predict life outcomes (Stillman et al., 2010) or indicators of subjective wellbeing (Crescioni et al., 2015). The second uses text based scripts to manipulate free will beliefs in order to impact socially relevant behaviors (Vohs & Schooler, 2008), or cognitions linked to individuals' sense of action control (Rigoni et al., 2011; Lynn, et al., 2014). The majority of current manipulations and measures of free will beliefs are predicated on the assumptions that lay persons see free will and determinism as incompatible

The most commonly used manipulations are the (Crick, 1994) and the Velten (1968) style manipulations made popular by Vohs and Schooler (2008).

Both these manipulations were constructed based on the assumption that laypersons see belief in free will and belief in determinism as incompatible. This assumption presupposes that an increased belief in determinism is conceptually identical to a reduced belief in free will (and vice versa). Free will and determinism are seen as opposite ends of the same continuum. The assumption that laypersons are incompatibilists also has implications for studies where a measure of scientific determinism is used to gauge the impact of an anti free will manipulation (see, e.g., Stillman and Baumeister, 2010). But if this assumption is wrong then manipulations containing both anti free will and pro determinism statements are actually manipulating two potentially unconnected concepts simultaneously. Furthermore, post manipulation measures of determinism shed no light on the relative success of an attempt to manipulate free will beliefs. In fact manipulation checks would need to measure all the different variables manipulated by multi- faceted manipulations.

The assumption that laypersons are incompatibilists is not based on solid empirical evidence when pertaining to many of the instruments currently used to measure belief in free will and determinism. For example Feldman et al. (2014) could identify no statistically significant correlations between the Scientific determinism subscale of the Paulhus and Carey (2011) instrument and either the General free will subscale(-.12), or the Personal free will

subscale (-.14), of the Rakos (2008) measure or with the FW subscale of the FAD-Plus (.00) (Paulhus & Carey, 2011).

This echoes similar findings during validation studies, demonstrating that, as intended, measures of free will and scientific determinism diverge, sharing no reliable relationships (see Paulhus & Carey, 2011 & Nadelhoffer, Shepard, Nahmias, Sripada & Ross, 2014). This led Paulhus and Carey (2011) to conclude that lay persons see free will and determinism as compatible, although other researchers claim to be agnostic on the subject of lay compatibilism/incompatibilism (Nadelhoffer, Shepard, Nahmias, Sripada, & Ross, 2014).

Research in the field of experimental philosophy also suggests that, when context and personal definitions permit, laypersons can be perfectly capable of reconciling a belief in free will with an acceptance of determinism (e.g., Nichols & Knobe, 2008, Nahmias, Morris, Nadelhoffer & Turner, 2006). As discussed above, current theoretical assumptions underpinning the Crick (1994) and Velten (1968) style manipulations, presuppose that lay understandings of free will and determinism are profoundly incompatibilist. They assume that higher levels of deterministic belief always equates to lower levels of free will belief (and vice versa); we will see if this holds true for the measures we are planning to use over the course of this research project.

Both the Crick essay (Crick, 1994) and the Velten (1968) style manipulations made popular by Vohs and Schooler (2008) contain both anti

free will and pro deterministic statements in their anti-free will condition, with the majority of the anti free will statements explicitly mentioning free will. But what does the term free will mean to participants? In other words, what is actually being endorsed or undermined by these manipulations? Across two studies Monroe and Malle (2010;2014) demonstrated that lay participants view free will as their capacity for making and executing choice and following desires, free from internal or external constraints (Monroe & Malle, 2010) with an additional element of forethought for a community sample containing older participants (Monroe & Malle, 2014). We will utilise a single item graphical slider that explicitly references the word free will in order to target this specific concept, while also recording participants' qualitative free will definitions. Content analysis of these free will definitions will allow us to replicate Monroe and Malle (2014) and explore for ourselves the concepts underlying lay belief in free will.

Participants' belief in both free will and determinism will be recorded via previously well validated multi item measures and our new single item graphical sliders. Work on validating these single item measures can initially involve their successful comparison to their already validated multi item counterparts.

The main achievement of Vohs and Schooler (2008) was to successfully induce cheating behaviour via a manipulation designed to undermine belief in free will (although as we have just discussed, the manipulation may have been

less focused than intended). Failed replications (Giner-Sorolla et al., 2015) suggest that attempts to induce cheating behaviour by manipulating free will belief could be at best inconsistent and at worst futile. If a relationship between manipulated belief in free will/determinism and cheating exists so should a relationship between pre-existing belief in free will/ determinism and cheating; at least any relationship that was born of actual belief rather than a secondary phenomenon based on having one's core beliefs challenged. We will attempt to demonstrate a link between pre-existing free will/deterministic belief and cheating via a new measure of cheating tailored to online application.

Aims

1. Verify, for our current sample, that participants' definitions of free will are in line with Monroe & Malle, (2014) centring around the capacity for choice and the ability to act free from constraints, with an element of forethought.
2. To begin validation of our single item measures of free will and scientific determinism.
3. To test the assumption that lay participants see free will and determinism as incompatible.
4. Establish whether participants' free will definitions predict cheating behavior.

Hypothesis

H1 That participants' free will definitions will be in line with the findings of Monroe and Malle, (2014) (community sample), in that they will centre around a capacity for choice and the ability to act free from constraints, with an element of forethought.

H2 Single item measures of free will and scientific determinism will demonstrate statistically significant and strong positive relationships to their well validated multi item counterparts.

H3 No consistent, reliable relationships between measures of free will and scientific determinism (both multi item and single item) will be observed.

H4 That participants' definitions of free will and their belief in the idea, will predict whether they cheat by providing false information on a survey task.

Method

Participants

Participants were recruited through the Prolific Academic web service (N = 94; 60% male; M_{age} = 28.33, SD_{age} = 10.02). Three additional participants were excluded for failing to complete at least 80% of the survey.

Procedure and Materials

Participants completed the following measures in order:

Free will definition. Participants' individual free will definitions were elicited following the procedure successfully used by Monroe and Malle (2010). Participants' open-ended responses to the question "Please explain what you think it means to have free will" (adapted from Monroe & Malle, 2010) were coded independently by the primary author and an independent associate. Nine major categories emerged from the qualitative data after an initial read through of the first 30 responses. (a) Philosophical (b) Control (c) Choice (d) Decide (e) Action (f) Future plans (g) Following desires (h) Overcoming constraints (i) Awareness of the Consequences of Actions (see Appendix 1 for coding instructions). In order for a participants' definition to be coded as philosophical they had to refer to decision making that was immune to the laws of causation or to act in a manner that was not pre-determined. To be coded as Control, Choice, Decide or Actions the target word simply had to be used. A response was coded as Future Plans when the definitions include references to future outcomes. Possible examples would be "choose my own course in life" or "bring about the outcomes I want". Responses were coded as Following Desires if they possessed an element of self-expression, for example, "doing what you want" or "Freedom to be me". To be coded as Overcoming Constraints the definition had to refer to a person's ability to resist external or internal influences, e.g "not being forced by others". Finally responses coded as Awareness of Consequences to Actions, demonstrated participants' awareness that their actions may lead to

consequences e.g be "prepared to accept the consequences". Inter-rater reliability for all coding categories was high (see Table 1)

Free will relevance. The personal importance of people's free will beliefs were then measured using a single-item, graphical slider scale ("How important is the idea of free will to you personally?"). The scale ranged from 0 (*not important*) to 100 (*very important*), and the starting position of the slider was set to the mid-point of the scale. This variable is expected to moderate the relationship between free will definition and cheating behaviour.

Free will and scientific determinism. Participants' belief in people's capacity for free will and their belief that deterministic forces can influence people's behaviour and life outcomes were measured using the two relevant subscales from the FAD-Plus, Paulhus and Carey (2011). The seven free will items (e.g., "Criminals are totally responsible for the bad things they do"; "People have complete free will") and the seven scientific determinism items (e.g., "People's biological makeup determines their talents and personality"; "Science has shown how your past environment created your current intelligence and personality") were intermixed at presentation. These two variables, constructed and validated by Paulhus and Carey (2011), have been shown to consistently load onto different factors and demonstrated no reliable relationship during validation. Participants indicated their level of agreement on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), with higher scores indicating a greater belief in the concept.

Belief in Free Will (slider measure). We measured participants' belief in free will, this time using a single-item, graphical slider scale ("Please indicate the extent to which you believe in free will"). The scale ranged from 0 (*no belief*) to 100 (*absolute belief*), and the starting position of the slider was set to the mid-point of the scale. Similar single item measures of free will have demonstrated predictive validity (e.g., Feldman, 2016), and single-item scales have been shown to be sensitive to experimental manipulations of free will beliefs (McKenzie, 2014).

Belief in Scientific Determinism (slider measure). We measured participants' belief in Scientific Determinism using a single-item, graphical slider scale ("Scientific Determinism is the idea that all human behaviour is governed by preceding events and scientific causal principles. Please indicate the extent to which you believe in Scientific Determinism."). The scale ranged from 0 (*no belief*) to 100 (*absolute belief*), and the starting position of the slider was set to the mid-point of the scale.

Demographics. Participants were asked to report their gender and age.

Cheating opportunity. Participants were then given an opportunity to cheat by making a demonstrably false claim. The task instructions read "This research has been sponsored by the Rassilion Trust. If you had not previously heard of the Rassilion Trust please give us 2 or 3 sentences describing how you feel we might better share our research findings with

members of the public like you. OR If you had previously heard of the Rassilion Trust please just simply write the words 'I had heard' in the box below". The name Rassilion Trust was fictional (no similarly named organisation appeared on internet searches). Participants who responded "have heard" were therefore coded as cheating.

Results

Unfortunately, an error occurred on the final page of our online survey. Thirty-five percent (n=33) of participants who failed to properly close the final page left no recorded cheating data. We could not be certain that a participant's disposition towards exiting the survey prematurely was independent of their responses on other measures. We therefore felt it inappropriate to test H4 or to proceed with any analysis that would use any of our measures to predict cheating behavior. Fortunately, this error did not impact the other data as these was recorded prior to the point when the error occurred.

Of the 61 participants who left cheating data, eighteen (29.5%) cheated. Thirty-four (55.7%) did not cheat and nine (14.8%) gave non appropriate answers that could not be coded as cheating or non cheating. We can at least conclude that a baseline cheating rate of approximately 30% does suggest that this cheating measure is suitable for further investigation.

Lay Definitions of Free Will.

Category codings for participants' free will definitions are shown in Table 1. As predicted, participants' definitions of free will were close to those observed by Monroe and Malle, (2014), with Choice (50%) and Overcoming Constraints (37%) the two largest individual categories. The combined categories also followed this pattern. 81% of participants' responses were coded within the combined category (composed of Control, Choice, Decide, Action) of Combined Action Plans This category involves making choices and executing actions.

60% of participants responded with definitions that were coded within the combined category (composed of Following Desires, Overcoming Constraints and Awareness of Consequences) of Combined Constraints. This category involves awareness of the constraints to actions that come from others.

The Forethought category (that represented 26% of Monroe and Malle, (2014) sample) related to responses that involved weighing the benefits of action and described choices as being thoughtful made in consideration of the future. In the present study the category Future Plans (8.8%) most closely resembles the Forethought category from Monroe and Malle (2014). The Desires category represented 38% of Monroe and Malle's (2014) responses. For our study the equivalent category, Following Desires, represented 28.6% of responses.

Even when allowing categories to emerge naturally from the qualitative data we have supported H1 by demonstrating that our participants free will definitions are in line with those observed by Monroe and Malle (2014). Free will is seen by lay community participants as essentially their capacity to make choices, that fulfils their desires, free from internal or external constraints (with an element of forethought).

Contrary to Monroe and Malle's, (2014) findings nearly 8% of participants responded with free will definitions that were coded as philosophical, conceptualising free will in a manner that grants humans the capacity for thoughts and actions that have a non-causal origin. As a precaution, responses coded as philosophical were searched online to check that participants had not copied there free will definitions from the internet. None of the responses we coded as philosophical appeared during our online search (see appendix 2 for participant responses that were coded as philosophical).

Table 1 *Content coding of lay definitions of free will.*

Coding category	Kappa of	Percentage of participants
Combined Action Plans		**81.3**
Combined Constraints		**60.4**
Choice	.96	49.5
Overcoming Constraints	.86	37.4
Decide	.91	34.1
Following Desires	.61	28.6
Actions	.90	20.9
Future Plans	.73	8.8
Philosophical	.93	7.7
Control	.90	6.6
Awareness of Consequences	.85	6.6

Note. Definitions for each coding category are provided in the text and see appendix 1 for free will definition coding instructions. All kappa agreements reached significance $p < .001$. Results are ordered from highest to lowest in terms of category inclusion.

Slider validation and the assumption of Incompatibilism

H2 was supported in that the slider measures of free will and scientific determinism demonstrated statistically significant and strong positive relationships with their multiple item subscale counterparts. This suggests that single item measures may provide adequate measurement of free will and scientific determinism.

Table 2. *Pearson's correlations for comparisons between single item slider and full subscale measures of free will and scientific determinism.*

	FAD-Plus FW	Slider FW	FAD-Plus SD
FAD-Plus FW	(.67)		
Slider FW	.460 (p<.001)	---	
FAD-Plus SD	.094 (p=.36)	-.236 (p=.02)	(.58)
Slider SD	.118 (p=.26)	-.073 (p=.49)	.492 (p<001)

Note. n= 94 or n=93 for the free will slider as 1 score missing. When applicable, alpha reliabilities are presented in parentheses along the diagonal.

The relationship between measures of Free Will and Scientific Determinism was less clear (see table 2). Of the four possible correlations that could have suggested a relationship, only the relationship between the single item Free Will measure and the multiple item Scientific Determinism measure was significant. H3 was therefore supported in that no consistent, reliable relationship was observed across the measures of free will and scientific determinism (both multi item and single item).

Discussion

This Study confirmed Monroe and Malle's (2014) findings that free will is seen by lay community participants as their capacity to make choices, that fulfil their desires, free from internal or external constraints (with an element of forethought). We begin validation of our single item measures of free will and scientific determinism and demonstrated that lay participants do not always see free will and determinism as incompatible. Technical problems meant that we were not able to test whether participants' free will definitions predicted cheating behavior, but our cheating measure did demonstrate a good baseline level of cheating.

Confirming H3, participants' responses on our new single item measures and their multiple item counterparts did not support an assumption of lay incompatibilism. Consistent reliable relationships were not observed across the different measures of free will and scientific determinism. A sensitivity power analysis demonstrated that our sample had 80% power to detect a moderate correlation of 0.28 or greater ($\alpha = 0.05$, two-tailed). Our sample may therefore have lacked the power to detect small effect sizes. However, Paulhus and Carey (2011) found no significant relationship between these free will and scientific determinism subscales, with 80% power to detect small correlations of 20 and greater ($\alpha = 0.05$, two-tailed). If a relationship between scientific determinism and free will exists, it may lack either sufficient reliability or

strength to support experimental methodologies that assume that a manipulated change in one variable reliably equates to an equal and opposite change in the other. At least not at meaningful effect sizes.

The free will and scientific determinism sub scales of the FAD-Plus did not correlate significantly either when there is 80% power to detect moderate correlations (this study) or indeed small correlations (Paulhus & Carey, 2011). These findings have implications for research that create global measures of free will (or intentional control) by reverse scoring responses on the free will subscale and combining it to 2 or 3 of the other subscales of the FAD-Plus

The potentially bogus assumption that lay participants always see belief in free will and determinism as incompatible may have implications for current manipulations. Most experimental studies seeking to manipulate free will belief, utilize either the Crick (1994) essay or the Velten (1968) style manipulations made popular by Vohs and Schooler (2008). Both manipulations are built upon the assumption that lay participants are incompatibilists, attempting to undermine free will belief (in the anti free will condition) by simultaneously promoting determinism and attacking the notion of free will. Our findings add to a growing body of research suggesting that lay participants are capable of holding beliefs about free will and determinism that are independent from one another. (Paulhus & Carey 2011 & Nadelhoffer, Shepard, Nahmias, Sripada, & Ross, 2014). The assumed

incompatibility of belief in free will and determinism may be as tenuous for manipulated beliefs is it appears to be for preexisting beliefs. Researchers should treat anti free will manipulations that simultaneously attack free will while championing determinism, as potentially targeting two distinct concepts. One of the aims of this thesis is to create more focused manipulations that either undermine belief in free will or champion determinism. Similarly, we will avoid using post manipulation measures of scientific determinism as proxy measures for belief in free will (and vice versa), as many researchers have done in the past.

Here, we aimed to begin the validation of more focused single item measures of free will and scientific determinism. Confirming H2 our single item free will slider and our single item scientific determinism slider both correlated significantly with their multiple item, well validated counterparts. These correlations were respectable and arguably approaching large according to the Cohen (1988) convention that views a value of .5 as large. However pertinent factors may have reduced the strength of the correlations between the single item measures and their multiple item counterparts. When comparing measures of scientific determinism we compared our new high concept single item measure (that we also defined) to the scientific determinism subscale of the FAD-Plus (Paulhus & Carey 2011) a simpler concept multiple item measure (with no definitions). This may have muddied the relationship between the two measures reducing the correlation. When

comparing measures of free will, we compared our single item measure of free will to the multiple item free will subscale of the FAD-Plus (Paulhus & Carey 2011). The free will subscale of the FAD-Plus is the most widely used measure of free will beliefs. However, as Nadelhoffer et al. (2014) and others have pointed out, this subscale contains multiple items relating to moral responsibility, a concept that closely overlaps with, but is not identical to, free will. The conceptual breadth of the free will subscale of the FAD-Plus may have reduced the strength of its correlation with our more focused single item measure.

Our qualitative analysis of participants' free will definitions confirmed H1 and past research, demonstrating that participants view free will as essentially their capacity to make choices, that fulfil desires, free from constraints (Monroe and Malle (2010) with an element of forethought (Monroe & Malle 2014). By contrast the two most widely used multiple item measures of free will contain items also relating to control, moral responsibility and arguably self-efficacy (Paulhus & Carey, 2011; Rakos, Laurene, Skala & Slane, 2008). These broad measures of free will belief, that also probe perceived choice, control, moral responsibility and self-efficacy, can never be effective tools for exploring the relationships between free will belief and perceived choice, control, moral responsibility and self-efficacy. We therefore see our single item measure of free will beliefs (which targets only participants' lay concept of free will), as the superior tool for exploring

relationships between free will beliefs and notions of control, choice and self-efficacy. How free will beliefs relate to notions of choice and control and how these beliefs influence subjective wellbeing, self-efficacy and moral behavior, will be key components of the research outlined in this thesis.

Limitations

Our findings diverged slightly from that of Monroe and Malle's (2010; 2014), with a small portion of our free will definitions coded as philosophical (See appendix 1 for coding instructions and appendix 2 for the participant definitions that were coded as philosophical). It is possible our inclusion criterion was too broad. For example, by coding responses as philosophical when participants state that their choices/behaviours are 'not predetermined', we may have inflated this category. This phrase could also be harnessed by young people who feel their life outcomes are constrained by societal and parental demands/expectation. Future research should endeavor to more precisely define what is and what is not, a philosophical definition of free will, perhaps by probing further and eliciting hypothetical scenarios and examples of when free will can and cannot exist. As previously mentioned, technical issues prevented us from testing the predictions of hypothesis 4 that participants' free will definitions will predict cheating. We will correct this technical issue in future studies.

To summarize, our lay participants' responses to multi and single item measures of free will and determinism add to the body of research that suggests that people do not always view free will and determinism as incompatible. This is problematic for paradigm standard manipulations that seek to undermine free will by simultaneously undermining belief in free will and championing determinism and for research that seeks to run the various FAD-Plus subscales together to create a global measure of free will. A more focused manipulation will be developed and used as a part of this research project. Our single item measures of free will and determinism appear suitable for further exploration over the coming studies. Our new online measure demonstrated a good baseline level of cheating and will be utilized as a part of this research project.

Summary and future directions

Study 1 confirmed past research by demonstrating that perceptions of possessing choice in the face of external constraints (with an element of forethought) form the core of lay persons free will beliefs (Monroe & Malle 2010; 2014). At least in terms of the single item and multiple item sliders tested in study 1, participants do not consistently see belief in free will and scientific determinism as incompatible, at least at moderate and large effect sizes. Our online cheating measure and our single item measures of free will and determinism, warrant further testing. Our results and past findings (Paulhus & Carey 2011 & Nadelhoffer, Shepard, Nahmias, Sripada, & Ross,

2014) suggest that better focused manipulations of free will and determinism should be developed.

Free will beliefs have been linked to indicators of subjective wellbeing predicting higher levels of satisfaction with life (Li et al., 2017) and lower levels of perceived stress (Crescioni et al., 2015). Yet as study 1 confirmed free will beliefs appear to draw largely upon notions of possessing choice (Monroe & Malle 2010; 2014) and we would argue, perhaps control. Studies 2 and 3 will use our new, more focused, single item measure of free will to establish that it is in fact peoples' sense of possessing choice/control that underpins the relationship between free will beliefs and subjective wellbeing.

Next step

Study 1 demonstrated initial validity for our better focused single item measures of free will and scientific determinism. Lay participants responses to these measures indicate that they do not consistently see free will and scientific determinism as incompatible, at least at moderate and large effect sizes. We broadly replicated the finding of Monroe and Malle (2014), demonstrating that lay participants define free will as their ability to make choices that fulfil their desires, free from internal or external constraints (with an element of forethought). We reasoned that executing a choice to fulfill a desire, unconstrained by others, is essentially an act of control. We suspected that it was this element of perceived choice/control (central to free will beliefs) that underpinned free will beliefs ability to predict important life outcomes. We tested for this possibility in chapter 4.

A version of this chapter has been published

Gooding, P. L., Callan, M. J., & Hughes, G. (2018). The association between believing in free will and subjective well-being is confounded by a sense of personal control. *Frontiers in psychology*, *9*, 623.

Chapter 4

The Association Between Believing in Free Will and Subjective Well-Being Is Confounded by a Sense of Personal Control

Abstract

The extent to which an individual believes in free will is associated with a number of positive life outcomes, including their own subjective well-being. However, it is not known whether the belief that one has free will per se is uniquely associated with subjective well-being over and above potential confounding variables. We examined a sense of personal control as one such confound—specifically, whether the association between free will belief (FWB) and subjective well-being is based, in part, on the degree to which an individual feels a sense of personal control over their life. In Study 2, trait-level belief in personal control significantly uniquely predicted satisfaction with life and stress, over and above the contribution of FWB. In Study 3, within-person daily fluctuations in stress and depression were not significantly predicted by daily changes in FWB over and above the contribution of personal

control/choice. The findings provide new insight into the relationship between FWB and subjective well-being.

Introduction

A growing body of evidence has shown that believing in free will is associated with a variety of positive life outcomes, including feeling grateful for past events (MacKenzie et al., 2014), better job performance (Stillman et al., 2010), higher academic achievement (Feldman et al., 2016), passionate love (Boudesseul et al., 2016), satisfaction with life (Li et al., 2017), and lower levels of perceived stress (Crescioni et al., 2015).

Nonetheless, the extent to which belief in free will *per se* is associated with positive life outcomes or whether some third variable is driving these associations remains to be explored. One possibility is that the relationship between free will beliefs (FWBs) and positive life outcomes, such as satisfaction with one's life, might be confounded by a sense of personal control. Indeed, it is well-established that a sense of personal control is positively associated with many of the same positive life outcomes that relate to FWB, including subjective well-being (for reviews, see Myers and Diener, 1995; Peterson, 1999; Ross and Mirowsky, 2013). Thus, it is unclear whether FWB are uniquely associated with indicators of subjective well-being over and above a sense of personal control.

In their work exploring lay understandings of free will, Monroe and Malle (2010, 2014) found that people's definitions of what it means to have free will differed from philosophical understandings that typically view free will as the ability for our conscious minds (or a soul) to make decisions, regardless of brain states or prior causal events (Harris, 2012). Rather, people defined free will as their freedom to make choices and the ability to act without constraints—that is, their sense of personal control (see also Baumeister and Monroe, 2014). Thus, insofar that our participants' lay concepts of FWB are specifically tied to having a sense of personal control, then individual differences in a sense of personal control might better predict subjective well-being than individual differences in FWB. Consistent with this idea, Monroe et al. (2017) found that people's beliefs that an agent who committed an immoral act had the capacity to choose their actions better predicted judgments of their blameworthiness than did their beliefs that the agent had free will. We reasoned that the known association between FWB and subjective well-being might be confounded by a sense of personal control.

Across two studies, we compared the relative predictive utility of perceived control/choice and FWB across various indicators of subjective well-being. Study 1 investigated the degree to which personal control and FWB uniquely predicted satisfaction with life and perceived stress. Study 2 assessed how daily changes in perceived choice/control and FWB predicted life stress

and depression across a 2-week period. Given the foregoing analysis, we predicted that the known associations between FWB and subjective well-being could be explained, in part, by people's perceived ability to have choice and to control their lives. In Study 2 we also assessed participants' qualitative definitions of free will, to investigate whether they fit with previously reported lay conceptions of FWB (cf. Monroe and Malle, 2010).

Aims

1. Demonstrate that it is the element of perceived control, that forms the core of lay free will concepts, that underpins free will beliefs utility for predicting subjective wellbeing.

Hypotheses for studies 2 and 3

H1 Both free will beliefs and perceived personal control will predict indicators of subjective wellbeing.

H2 When the predictive utility of free will belief and perceived personal control are tested simultaneously. Only perceived personal control will significantly predict indicators of subjective wellbeing.

H3 Participants' lay free will definitions will be consistent with the findings of Monroe and Malle (2010, 2014), centring around the ability to decide/choose, doing what one wants, and/or being free of constraints.

Study 2

Method

Participants

Participants from the United States were recruited through Amazon's Mechanical Turk (N = 284). Demographic information was not collected (but see Levay et al., 2016, for information on the typical demographic composition of Mechanical Turk workers). Nineteen additional participants were excluded because of duplicate IP addresses (n = 6) or failing a basic attention check item (n = 13). A power analysis showed that our sample size had 80% power to detect "small-to-medium" effect sizes (f^2 = 0.028; α = 0.05, two-tailed) in our multiple regression analysis.

Procedure and Materials

Participants were instructed that they would complete a survey about their beliefs and opinions. We measured participants' belief in free will using a single-item, graphical slider scale ("Using the slider provided, please indicate the extent to which you believe in free will"). The scale ranged from 0 (*no belief in free will*) to 100 (*absolute belief in free will*), and the starting position of the slider was set to the mid-point of the scale. Similar measures have been shown to have good convergent (Schooler et al., 2014) and predictive

(e.g., Feldman et al., 2016) validity, and single-item free will measures have been shown to be sensitive to experimental manipulations of FWBs (MacKenzie et al., 2014; Nahmias et al., 2014; Monroe et al., 2017).

Participants' sense of personal control was gauged using a five-item measure (e.g., "Other people determine most of what I can and cannot do"; "There is little I can do to change many of the important things in my life"; "I can do just about anything I really set my mind to"; Chou et al., 2016, adapted from Lachman and Weaver, 1998). Participants indicated their level of agreement on a five-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores indicate a greater sense of personal control.

Participants' perceived stress was measured using two items: "In the past year, how would you rate the amount of stress in your life (at home and at work)?" (1 = *no stress* to 6 = *extreme stress*; Littman et al., 2006) and "Stress means a situation in which a person feels tense, restless, nervous, or anxious or is unable to sleep at night because his/her mind is troubled all the time. Do you feel this kind of stress these days?" (1 = *not at all* to 6 = *very much*; Elo et al., 2003). Responses to the two items were highly correlated ($r = 0.73$, $p < 0.001$) and therefore averaged to form a composite measure of perceived stress.

Participants' life satisfaction was measured using Diener et al. (1985) widely used Satisfaction With Life Scale (SWLS), which is comprised of five items (e.g., "In most ways my life is close to my ideal"; 1 = *strongly*

disagree to 7 = *strongly agree*). Alpha reliabilities for all measures with more than one item are shown in Table 1.

Results and Discussion

Table 1 presents descriptive statistics, alpha reliabilities, and correlations among the measures. All of the measures correlated significantly in the expected directions. FWB positively correlated with sense of personal control, and both correlated positively with SWL and negatively with perceived stress.

Table 1. *Descriptive statistics and correlations among measures in Study 2*

Measures	Mean	(*SD*)	1.	2.	3.	4.
1. FWB	82.52	(19.57)	--			
2. Control	3.82	(.83)	.426**	(.83)		
3. SWLS	4.20	(1.44)	.254**	.510**	(.97)	
4. Stress	3.61	(1.25)	-.145*	-.424**	-.409**	(.83)

Note. SWLS= the Satisfaction With Life Scale. When applicable, alpha reliabilities are presented in parentheses along the diagonal. * $p < .05$ ** $p < .01$.

A series of regression analyses supported H1 and H2 in that, both sense of personal control, b = 0.88, β = 0.51, SE = 0.09, $t(281) = 9.94$, $p < 0.001$, sr^2= 0.51, and free will beliefs, b = 0.02, β = 0.25, SE = 0.004, $t(281) = 4.42$, $p <$ 0.001, sr^2= 0.25, predicted scores on the SWLS. However when both predictors were entered into the model simultaneously personal control, b = 0.85, β = 0.49, SE = 0.10, $t(281) = 8.65$, $p < 0.001$, sr^2= 0.44, but not FWB, b = 0.003, β = 0.05, SE = 0.004, $t(281) = 0.81$, $p = 0.42$, sr^2 = 0.04, uniquely predicted scores on the SWLS.

Likewise H1 and H2 were supported in that, both sense of personal control, b = -.64, β = -0.42, SE = 0.08, $t(281) = -7.86$, $p < 0.001$, sr^2= -0.42, and free will beliefs, b = -.01, β = -0.15, SE = 0.004, $t(281) = -2.46$, $p < 0.05$, sr^2= -0.15, predicted perceived stress. However when both predictors were entered into the model simultaneously, personal control, b = -0.67, β = -0.44, SE = 0.09, $t(281) = -7.42$, $p < 0.001$, sr^2 = -0.40, but not FWB, b = 0.003, β = 0.04, SE= 0.004, $t(281) = 0.73$, $p = 0.46$, sr^2 = 0.04, uniquely predicted perceived stress.

These results suggest that the associations between FWB and SWL, and FWB and perceived stress are largely due to co-variation between FWB and a sense of personal control.

Study 3

Method

Participants

The final sample of participants were 88 staff or students from the University of Essex (M_{age} = 24.18, SD_{age} = 6.50; 77% female) who participated in exchange for a monetary reward ($1 for an initial session and $1 for every daily diary completed) and the chance to win gift cards. Two additional participants completed measures during an initial session but did not complete any of our focal daily measures. The final sample size was determined by how many participants we could recruit within our monetary budget and time constraints.

Procedure and Measures

Participants attended an initial laboratory session where they completed a variety of measures unrelated to the current project. Of relevance here, during this initial session participants were asked to respond to an open-ended question about their FWBs: "Please explain what you think it means to have free will" (Monroe and Malle, 2010). Responses to this question were coded by two raters using Monroe and Malle's (2010) original coding scheme. We included this question to replicate Monroe and Malle's (2010) findings surrounding what "free will" means to people.

At the end of the initial session, participants were informed that they would receive daily emails including a link to a 10-min survey. The daily surveys were emailed to participants every day for 14 days at 5:00 PM; they had until 3:00 AM to complete the daily surveys. Participants who failed to complete more than five daily surveys were removed from the study (i.e., no longer sent the email links), but all data from participants who completed at least one daily survey were retained for analysis. Along with several questions unrelated to the current research interests, participants completed the following daily measures:

We measured participants' daily FWB using a single-item, graphical slider scale ("Using the slider provided, please indicate the extent to which you believed you had free will today"). The scale ranged from 0 (*no belief in free will today*) to 100 (*absolute belief in free will today*).

We measured participants' sense that they controlled their actions and were free to choose that day using single-item, graphical slider scales ("Using the slider provided, please indicate the extent to which you believed you were in control of your actions today"; "…you were free to choose whatever you wanted to do today"). Scores could range from 0 (*no control/no choice at all today*) to 100 (*complete control/complete choice today*). Scores on these two daily measures were averaged to form a composite control/choice variable (within-person reliability = 0.54; see Nezlek, 2017).

As our focal criterion variables, we measured participants' daily stress ("Today, I felt stressed") and daily depression ("Today, I felt depressed") using four-point scales (1 = *not at all*, 4 = *very much*). Depression is an element of the unpleasant affect component of subjective well-being (Diener et al., 1999).

Results and Discussion

Lay Definitions of Free Will

We coded participants' open-ended responses using Monroe and Malle's (2010) coding scheme. Specifically, we coded the responses the question "Please explain what you think it means to have free will" in terms of whether participants noted: (a) making decision or choices, (b) doing what they want, and (c) acting without internal or external constraints.

H3 was supported in that participants' lay definitions of free will were consistent with the findings of Monroe and Malle (2010, 2014). Table 2 demonstrates that the majority of participants' definitions of free will referred to the ability to decide/choose, doing what one wants, and/or being free of constraints. During the coding and analysis it was also clear that none of our participants defined free will as reliant upon notions of indeterminism, magical causation or other qualities needed for the type of free will debated by philosophers (see Monroe and Malle, 2010; Baumeister and Monroe, 2014, for discussions).

Table 2. *Content coding of the folk definitions of free will.*

Coding category	Percentage coder Agreement	Kappa of Agreement	Percentage of participants mentioning the category
Ability to decide/choose	91%	.81	64%
Doing what you want	84 %	.69	50%
Acting without constraints	87%	.72	69%

Note. Definitions of coding categories were taken from Monroe and Malle (2010)

Daily Stress and Depression

Given the nested structure of the data (daily responses nested within participants), analyses were performed using multilevel modeling (Nezlek, 2012). Analyses were performed using the lme4 package (Bates et al., 2015) in R, with maximal but uncorrelated random effects (i.e., random slopes and intercepts by participants; including correlations among the random effects led to problems with convergence; Barr et al., 2013). All predictors were person-centred to control for between-person variance in the predictors. We did not model time (days) because we had no theoretical reason to expect time to influence daily changes in stress or depression across the 14-days.

On average participants completed 10.74 (*SD* = 3.75) of the 14 daily surveys (range = 13; total daily surveys completed = 944). Table 3 shows

descriptive statistics and the proportion of variance at the within- and between-person levels for each of the measures we employed.

Table 3. *Means, standard deviations, and proportion of variance in the predictors and outcome variables at the within- and between-person levels.*

	M	*SD*			
Measures		Between		Within	
Choice/Control	75.99	17.06	(60%)	13.84	(40%)
FWB	75.49	20.75	(61%)	16.73	(39%)
Stress	2.28	0.63	(38%)	0.79	(62%)
Depression	1.82	0.64	(44%)	0.72	(56%)

As expected, daily fluctuations in choice/control were significantly associated with daily fluctuations in participants' FWB, b = 0.51, SE= 0.07 (95% Wald confidence interval [CI]: 0.38, 0.65; here, FWB was the outcome variable in the analysis). Table 4 demonstrates that H1 and H2 were supported in that, both daily FWBs and daily choice/control beliefs significantly predicted daily fluctuations in stress and depression when modeled alone. However, when daily FWBs and daily choice/control were modeled together to predict daily stress and depression, only daily choice/control emerged as a significant predictor. Put differently, at the within-person level, daily changes in FWBs did not account for significant variability in daily stress and depression over and

above the contributions of daily changes in choice/control. Figure 1 shows the means of FWB, choice/control, stress, and depression across the 14 days.

Table 4. *Linear mixed effects models predicting daily stress and daily depression from daily FWB and daily choice/control (alone and simultaneously).*

	Daily FWB			Daily Choice/Control		
	b	***se***	**Wald 95% CI**	***b***	***se***	**Wald 95% CI**
Daily Stress						
FWB alone	**-0.007***	0.002	[-0.012, -0.002]	--	--	--
Choice alone	--	--	--	**-0.010***	0.003	[-0.015, -0.004]
FWB & Choice	-0.002	0.002	[-0.006, 0.002]	**-0.009***	0.003	[-0.014, -0.003]
Daily Depression						
FWB alone	**-0.008***	.003	[-0.013, -0.003]	--	--	--
Choice alone	--	--	--	**-0.011***	0.003	[-0.017, -0.007]
FWB & Choice	-0.002	-0.002	[-0.007, 0.002]	**-0.01***	0.003	[-0.016, -0.005]

Note. FWB = Free will belief. * $p < .05$ (based on the Wald 95% confidence interval not containing zero).

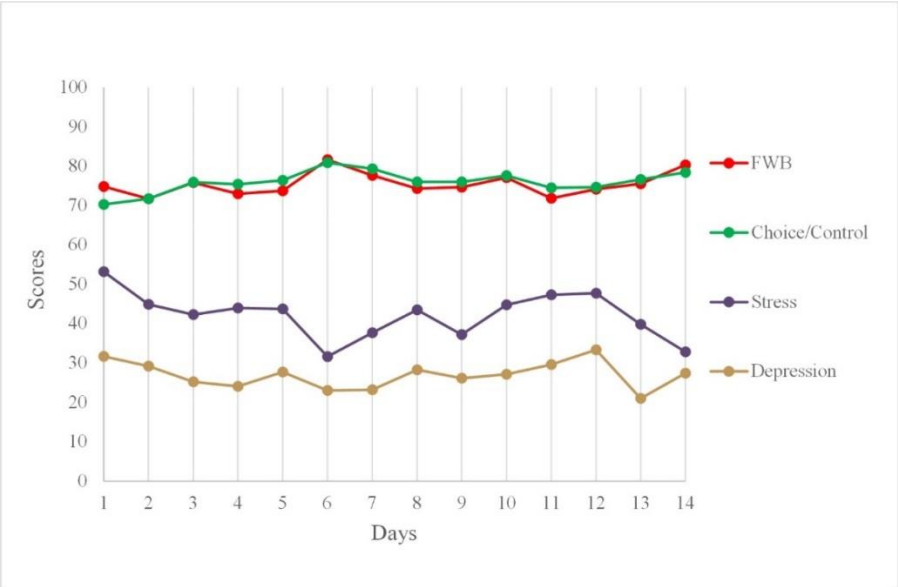


Figure 1, Mean levels of the two main predictor variables (combined choice/control and free will beliefs) and the two criterion variables (stress and depression) across days. Stress and depression have been rescaled (from 1–4 to 0–100) for illustration.

These findings are consistent with our trait-level findings reported in Study 1: associations between participants' subjective well-being (in this case, daily stress and depression) and FWBs appear to be due to the co-variation between FWB and beliefs about having control and being able to choose.

General discussion

Across two studies we investigated the role of personal control and choice in the relationship between FWB and subjective well-being. Previous research has provided evidence for the predictive value of FWB on such outcomes (e.g., Crescioni et al., 2015). Here, we show that this association can be explained by perceived control/choice. Study 1 showed that trait-level belief in personal control significantly uniquely predicted SWL and stress, whereas FWB did not. Study 2 confirmed that within-person daily fluctuations in stress and depression are not significantly predicted by daily changes in FWB over and above the contribution of personal control/choice.

Previous research has shown that the association between FWB and judgments of others' morality/blame is due to perceived capacity for choice (Monroe et al., 2017). The current studies extend this by showing that like judgments of others' behavior, the relationship between FWB and personal life outcomes, relevant to subjective well-being, is also due to co-variation with control/choice. Crescioni et al. (2015) showed that although both self-efficacy and locus of control were correlated with FWB, they did not explain the association between FWB and life outcomes (meaning in life and SWL). We chose to focus on measures of control/choice that more closely reflected the nature of layperson conceptions of free will (Monroe & Malle, 2010). Unlike Monroe et al. (2017), who manipulated/measured choice using

vignettes, we used a self-report measure of the degree to which participants believed in the ability to control their behavior or have the capacity for choice. These measures effectively captured the key elements of the lay concepts of free will to the extent that they reduced the predictive utility of FWB on perceived stress and depression.

Much recent research has investigated the role of FWBs in a number of life outcomes, as well as psychological well-being. Here, we provide evidence for the role of personal control/choice in explaining why FWB predicts stress and depression. For laypeople, belief in free will fundamentally means having the capacity to make choices and control one's life (Monroe & Malle, 2010), and our Study 2 findings of participants' definitions of free will confirm this. This perception of personal control appears to be protective of perceived stress and depression such that individuals with strong belief in the degree to which they control their lives may be less likely to negatively react to stressful life events. We also provide further evidence for the role of perceived control in stress and depression. This goes beyond previous research, by utilizing measures of control/choice that are closely aligned to high level beliefs in free will. Future research should investigate the relative power of these different aspects of choice in predicting stress and depression.

Although we show that the predictive utility of FWB on personal life outcomes is abolished when controlling for personal choice, it remains possible that FWB does have unique predictive utility in other contexts.

Indeed, the modest correlation between FWB and personal control suggests that FWB and personal control are not precisely the same thing. Nonetheless, recent work (Monroe et al., 2017) shows that the relationship between FBW and morality is similarly explained by notions of personal control. As such future research should seek to determine which behaviors or outcomes might be predicted by FWB over and above personal control.

Further research should also attempt to identify the direction of these relationships. For instance, much research on FWB assumes that belief or disbelief in free will drives life outcomes and personal well-being. However, while control beliefs influence how someone copes with a stressful event, this coping also feeds back into the individual's sense of personal control (Anderson, 1977). As such, while belief in free will/choice may be protective of subjective well-being, stressful life events may also lead to a reduction in a sense of personal control.

Next step

Study 1 (chapter 3) demonstrated initial validity for our better focused single item measures of free will and scientific determinism and added to the growing body of evidence suggesting that lay participants do not always see belief in free will and scientific determinism as incompatible, at least at non trivial effect sizes. We broadly replicated the finding of Monroe and Malle (2010; 2014), that lay free will concepts centre around choice capacity.

Studies 2 and 3 (chapter4) revealed that the documented relationship between free will beliefs and indicators of subjective wellbeing (Li et al., 2017; Crescioni et al., 2015) are due to the covariation of free will beliefs and sense of personal choice/control.

We reasoned that, as pro deterministic/anti free will messages can undermine free will beliefs (Vohs and Schooler, 2008), these manipulations may also impact perceived control and subsequently indicators of subjective wellbeing. Chapter 5 begins this work by exploring the impact of pro determinism/anti free will texts on perceived control.

Chapter 5

Manipulations designed to undermine belief in free will, can also undermine perceived control.

Abstract

One of the most common ways to manipulate people's belief in free will is to provide them with a written text, such as a passage from Francis Crick's "Astonishing Hypothesis", a text that uses a broad ranging deterministic argument as part of an attack on the idea that free will exists. Following on from the previous chapter, here we examined whether the Crick essay would influence measures of perceived control. Such a finding would suggest that, like the link between individual differences in free will belief and subjective wellbeing explored in the last chapter, any effect of manipulating free will using this text may act through sense of personal control. Studies 4 and 5 demonstrated that although the full version of the Crick manipulation failed to manipulate participants' sense of control in terms of personal mastery and freedom from constraints, a more focused version can impact participants' perceived control relating to their capacity to make choices and decide on actions.

Introduction

In Study 1 (chapter 3) we broadly replicated the finding of Monroe and Malle (2014), demonstrating that lay participants define free will as their ability to make choices that fulfil their desires, free from internal or external constraints (with an element of forethought). We conceptualize executing a choice to fulfill a desire, unconstrained by others, as an act of control.

Free will beliefs predict indicators of subjective wellbeing with higher belief in free will predicting greater satisfaction with life (Li et al., 2017), and lower perceived stress (Crescioni et al., 2015). Studies 2 and 3 demonstrated that an individual's sense of control covaries with, and better predicts these 2 indicators of subjective wellbeing than free will beliefs. It is this element of perceived choice and control, inherent to understandings of free will that underpins the documented relationship between free will beliefs and indicators of subjective wellbeing.

Free will beliefs can be manipulated via written texts that, dependent upon condition, either undermine, support or are neutral concerning the existence of free will. Vohs and Schooler (2008) successfully used an essay by the Nobel-prize-winning scientist Francis Crick (1996) to undermine participants' belief in free will (relative to a control passage on consciousness). This manipulation has since been used successfully in multiple studies to undermine belief in free will or bolster belief in determinism (Lynn, Muhle-

Karbe, Aarts & Brass, 2014; MacKenzie, Vohs & Baumeister, 2014; Rigoni, Kühn, Sartori & Brass, 2011; Rigoni, Wilquin, Brass & Burle, 2013; Vohs & Schooler, 2008).

The overlap between belief in free will and perceived control (outlined in studies 2 and 3 in chapter 4) has implications for research that uses written texts (such as the Crick essay) to manipulate free will beliefs, cognitions (Rigoni et al., 2011), attitudes (MacKenzie et al., 2014) and behaviours (Vohs & Schooler, 2008).

Typically a measure of free will or determinism (or both) is used to gauge the effectiveness of a free will manipulation (see Mele, 2014 for an overview of the literature). The implicit assumption being that the manipulation impacted the dependent measure by undermining the participants' free will belief. However if manipulations like the Crick essay also impact perceived control (as well as free will beliefs) then the impact of the anti free will manipulation on the dependent measure may operate exclusively via perceived control. The apparent association between the manipulation, the dependent measure and free will beliefs may merely be spurious.

Although some researchers highlight that free will beliefs draw upon perceptions of control over one's actions (Lynn et al,. 2014; Rigoni et al., 2011; 2013) and life outcomes Crescioni eat al., 2016) a finding that the Crick essay can impact perceived control would invite a reinterpretation of the current literature and a re-examination of previous findings to ascertain the relative

contributions of perceived control and free will beliefs for those dependent measures. New avenues of research could explore the impact of deterministic texts on previously unexplored cognitions behaviours and life outcomes related to perceived control. More work would also need to be done to understand any unique role of free will beliefs, distinct from its covariation with perceived control (see Feldman, 2017 for an example). The first step in demonstrating that anti-free will manipulations impact cognitions, attitudes and behaviours via perceived control rather than free will beliefs, will be to demonstrate that the Crick essay can undermine participants' perceptions of having control.

Aims

The aim of studies 4 and 5 was to establish whether reading the Crick essays, successfully used in previous research to manipulate belief in free will and behavior, can also impact participants' sense of having control.

Study 4

Hypothesis

H1 participants exposed to a pro deterministic/anti free will/anti-religious essay will report lower levels of perceived control than participants exposed to an essay on consciousness.

Method

Participants

Participants were 173 U.S. residents (57% male M_{age} = 34.49, SD_{age} = 11.17) who completed an online survey through MTurk. Thirty-three additional participants were excluded because of duplicate IP addresses (n = 6) or failing a basic attention check items (n = 27). A sensitivity power analysis showed that our sample size had 80% power to detect medium effect sizes (d = .42, α = 0.05, two-tailed).

Procedure and Materials

Participants completed the following measures in order. The first two measures listed below (manipulation) were presented in random order between participants:

Manipulation. The Crick essay manipulation is typically used to modulate free will belief**.** Participants read one of two extracts from in *The Astonishing Hypothesis* a book written by Nobel-prize-winning scientist Frances Crick (1996). Participants in the deterministic condition read an essay that makes the claim that free will does not exist, while putting forward an explanation for human decision making based on neuro reductionist scientific theories and anti-religious arguments. Participants in the control condition read a passage that outlined the challenges of researching human

consciousness. This passage did not mention free will and had less neuro reductionist content.

These materials have been shown to manipulate participants' free will beliefs in a manner amenable to measurement via well validated measures of free will belief, such as the Fad-plus (Paulhus & Carey 2011) and have been utilised to both influence social behaviour (Vohs & Schooler 2008) and explore correlational relationships (Crescioni, Baumeister, Ainsworth, Ent & Lambert, 2015).

Control. To assess participants' subjective sense of possessing control, we used the 5 item sense of personal control measure used by Chou and Parmer (2016) adapted from Lachman and Weaver (1998). This measure was comprised of 5 items targeting two distinct aspects of perceived control: one measure being people's sense of personal mastery (2 items, e.g., "I can do just about anything I really set my mind to."; "When I really want to do something, I usually find a way to succeed at it"); the other measure being people's sense of being constrained in their intentions (3 items, e.g., "There is little I can do to change many of the important things in my life"; "Other people determine most of what I can and cannot do"). Participants indicated their level of agreement on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), with higher scores indicating a greater sense of control (3 items were reverse coded). Both higher scores on mastery and lower scores on perceived

constraints have been related to better health, greater life satisfaction and lower levels of depressive symptoms (Lachman & Weaver 1998).

Demographics. Participants reported their gender and age.

Task Engagement. Participants were asked to read four sentences and identify the one that summarised the content of the essay or passage that they read.

Results

Participants who read the neutral text (N=93) reported levels of control (M =3.75, SD =0.79) that did not differ significantly from participants (N=80) who read the deterministic text (M=3.73, SD = 0.84), $t(171)$ = -.21, p =0.83. Study 3 showed that the Crick manipulation of people's belief in free will and determinism did not result in changes to their perceived sense of having control.

Discussion.

The lack of significant mean differences between the conditions may have been due to the nature of the measure of control used. We used the personal control measure adapted by Chou and Parmer (2016) and created by Lachman and Weaver (1998). This instrument was initially designed to target two distinct aspects of perceived control: (1) Personal Mastery, an individuals' sense of effectiveness in carrying out life goals; and (2) Constraints, their

sense of feeling constrained in their intentions. Such self-perceptions likely develop over long periods of time during interactions with others and are therefore potentially slow to change. Essentially this measure may tap more into trait perceived control. A more state based measure that targets perceptions of one's immediate sense of control over choices, decisions and outcomes may be more vulnerable to short term manipulation via the Crick essay.

Study 5

In the last study reading the Crick essay failed to significantly impact control in the form of participants' sense of having mastery and being free from constraints.

The aim of this study 5 was to examine whether reading the Crick essays, can impact impacts participants' sense of having a different form of control. Control, in this study being their capacity to make choices and decide on actions. In other words, the extent to which they feel that they are the true author of their actions. This conceptualisation of control is closer to the understanding of free will undermined by the Crick essay.

Method

Participants

Participants were 115 U.S. residents (56% male; M_{age} = 37.14, SD_{age} = 12.40) who completed an online survey through MTurk. Ten additional participants were excluded because of failing a basic attention check item. A sensitivity power analysis showed that our sample size had 80% power to detect medium effect sizes (f2 = 0.52, α = 0.05, two-tailed).

Procedure and Materials

Participants completed the following measures in order. The first two measures listed below (free will manipulation), were presented in random order between participants:

Free will manipulation. Participants were presented with either a neutral passage about consciousness or a pro determinism, anti free will essay. These two passages were modified versions of the full stimuli used in Study 4 that had been shortened in order to increase participant engagement with the stimulus and focus the manipulation by removing references to religious notions of the soul and after life that only indirectly relate to notions of free will (see appendix 3). Both passages were preceded by a short biography of Francis Crick (Rigoni, Kühn, Sartori & Brass, 2011). It has been argued that the inclusion of biographical information that emphasises the academic status of Frances Crick increases the impact of the stimuli on participants' free will evaluations and moral behaviours (Schooler 2014). Before being presented with the passage, participants were advised that they

should carefully read it because they would be asked to provide a later summary of its subject.

Control. In study 4 we used the measure of control from study 2 (chapter 4). This measure had been used successfully to demonstrate that the documented relationship between free will beliefs and subjective wellbeing was due to free will beliefs covariation with sense of control. This measure of control (Lachman & Weaver, 1998; Chou et al., 2016) taps into participants' perceptions of control in terms of their perceived mastery and freedom from constraints, perceptions central to the lay understanding of free will (Monroe & Malle, 2010; 2014). In Study 4 this measure of control did not prove susceptible to manipulation via the full Crick essay.

For Study 5 then, we decided to utilise a measure of control more relevant to perceived decision making and control over actions. This conceptualisation of control is closer to the understanding of free will that is disputed by the Crick essay. Participants' sense of having control was assessed using 3 questions. The first question ("To what extent do you believe that you are in control of your actions?") and the third question ("To what extent do you believe that the decisions you make are determined by you?") were created specifically for this research. The second question ("To what extent do you believe that you are free to choose whatever you want to do in your life?") was adapted from Baumeister, Masicampo and DeWall (2009) and has proven susceptible to manipulation from similar deterministic stimuli

Baumeister (2009). All three items loaded onto a single principal component (eigenvalue = 2.58, 86.08% of the variance accounted for) and the scale demonstrated acceptable internal consistency (α=.92). For each question participants indicated their level of agreement on a 9-point scale ranging from 1 (*Not at all*) to 9 (*Entirely*) with all other scale-points represented only numerically. Higher scores indicated a greater sense of control.

Demographics. Participants reported their gender and age.

Task Engagement. Participants were asked to read four sentences and identify the one that summarised the content of the essay or passage that they read.

Results and Discussion

Control item factor loadings and communalities are displayed in table 4. Participants who read the neutral text (N=56) reported greater levels of control (M =7.35, SD = 1.08) than participants (N=59) who read the deterministic text (M =6.60, SD = 1.74), $t(98) = 2.80$, p =.006, d =.53.

Study 4 showed that a manipulation that undermined belief in free will while championing determinism resulted in participant's reporting a reduced sense of having control over their actions and decisions.

Table 4. *Scale Items, Principal Component Loadings, and Communalities for the 3-item control scale*

Scale items	Component loading	Communality
1. To what extent do you believe that you are in control of your actions?	.942	.886
2. To what extent do you believe that you are free to choose whatever you want to do in your life?	.919	.845
3. To what extent do you believe that the decisions you make are determined by you?	.923	.851

Discussion

The studies in this chapter aimed to investigate whether participants' sense of having control could be undermined by a text based manipulation (the Crick essay) that is typically used to undermine belief in free will. In study 4 the Crick manipulation failed to impact notions of control associated with people's perceptions of having mastery and being free from constraints. Study 5 established that a more focus version of the Crick manipulations can impact notions of control relevant to perceived decision making and control over actions. This conceptualisation of control is closer to the understanding of free will disputed by the Crick essay. The impact of the Crick manipulation on free will beliefs, cognitions and attitudes has already been well established in

the literature (Lynn, Muhle-Karbe, Aarts & Brass, 2014; MacKenzie, Vohs & Baumeister, 2014; Rigoni, Kühn, Sartori & Brass, 2011; Rigoni, Wilquin, Brass & Burle, 2013; Vohs & Schooler, 2008). Studies 2 and 3 established that the relationship between free will beliefs and indicators of subjective wellbeing is in fact due to free will beliefs covariation with perceived control. It now seems plausible that the capacity of anti free will manipulations, to impact cognitions and attitudes, may also exploit fluctuations in perceived control rather than free will beliefs. To establish this, future research will need to demonstrate that the impact of anti free will manipulations, on the range of dependent measures so far tested, was indeed due to the mediating effect of perceived control rather than free will beliefs.

In sketching out this future research it is also important to consider the limitations of the current study. Study 5 measured control in terms of participants' perceptions of having the capacity to make choices and decide on actions. This conceptualisation of control was closer to the understanding of free will that is disputed by the Crick essay. This approach means that there is overlap between the language used in the manipulation and the language of the items used to measure control. This language overlap increased the likelihood that demand characteristics may have influenced participants' responses. However the overlap between the language of the Crick essay and the language of the measure of control used in study 5 does not appear to be greater than the overlap between the language of the Crick essay and the

language used in the multi item measures of free will used in the majority of free will research (see Paulhus & Carey, 2011; Rakos et al., 2008). Nevertheless these potential demand characteristics should be addressed. To that end we will attempt to design and test a better focused manipulation that can undermine perceptions of having free will without encouraging demand characteristics.

Next step

In study 1 we confirmed past research demonstrating that perceptions of possessing choice/control and being free from constraints are at the heart of peoples' free will beliefs (Monroe & Malle, 2010; 2014). In studies 2 and 3 we established that peoples' sense of possessing choice and control underpins the relationship between free will beliefs and subjective wellbeing. As pro deterministic/anti free will messages can undermine free will beliefs we reasoned that these manipulations may also impact perceived control and subsequently indicators of subjective wellbeing. Chapter 5 established that a modified (shortened) version of the Crick essay) impacted control beliefs relating to notions of having control over actions and decisions (study 5). This modified version of the Crick manipulation was still quite broad and likely to prompt demand characteristics. We therefore set out to develop a more powerful, better focused yet implicit manipulation and compare its ability to undermine free will beliefs to that of the Crick essay. In chapter 6 we did not test the impact of our 2 manipulations on participants' sense of possessing choice or control. Our reasons for this are twofold. Firstly, the impact of the (modified) Crick essay on perceived control was established in study 5. Secondly if our new TMS manipulation successfully undermines belief in free will in the current study it will be harnessed in a final study to impact socially relevant behaviour and life outcomes. That final study will include a then validated TMS manipulation and have no need of a third (Crick) condition.

Chapter 6

Study 6

Creating a new manipulation of free will beliefs and testing its effectiveness against the paradigm standard text-based approach.

Abstract

The Crick essay manipulation is a written text used to undermine belief in free will and is one of the most commonly used manipulations in the free will literature. It was written as an essay and designed to be a multipronged attack on religious and mythical notions of the soul, free will and the afterlife and an endorsement of reductionist, scientific, deterministic accounts of human thought and decision making. The current research explored for the first time, how the Crick essay is actually understood by participants. In addition to this the capacity of the Crick essay to undermine free will beliefs were compared to a new manipulation that harnesses transcranial magnetic stimulation (TMS) to impact participants' sense of being able to execute a volitional action (drinking form a bottle of water). Our findings demonstrated the unfocused and multi-faceted nature of the Crick essay and highlighted its potential to induce demand characteristics even when presented to the participants separately from the dependent measures. After controlling for pre

manipulation free will beliefs the TMS manipulation did not reduce post manipulation free will scores relative to controls. Nonetheless, a significant within condition reduction was observed between the pre manipulation and post manipulation scores in all three conditions. An examination of potential reasons for this, hinted at the possible utility for TMS (or other similarly intimidating procedures) to undermine free will beliefs if harnessed effectively.

Introduction

Presenting participants with deterministic texts that challenge their belief in free will can impact behaviour and attitudes (Vohs & Schooler, 2008; Baumeister, et al ., 2009; Alquist et al., 2013; Zhao et al.,, 2014). The two most widely used manipulations of free will beliefs were both introduced by Vohs and Schooler (2008). These are, 1) the anti free will essay from Francis Crick's book 'The astonishing hypothesis' (Crick 1994) that is compared experimentally to a neutral passage on consciousness from the same book. 2) the set of 15 Velten (1968) style statements that either challenge free will, are pro free will or contain neutral statements. Both the Crick and Velten style manipulations are broad ranging simultaneously manipulating multiple concepts. It is currently unknown what exactly is being manipulated by the Crick essay. We will therefore explore what the Crick manipulation actually

means to lay participants in order to better understand which of the concepts manipulated is likely driving any observed effects.

The lack of conceptual focus, along with replication issues (Giner-Sorolla, Embley & Johnson, 2015) with the original study by Vohs & Schooler (2008) and difficulties with establishing a consistent effect (Schooler, Nadelhoffer, Nahmias & Vohs, 2014) led some researchers to construct new free will manipulations (Shariff, Greene, Karremans, Luguri, Clark, Schooler & Vohs, 2014; Zhao et al., 2014; Monroe Brady & Malle 2017). All these examples use written texts and only partially reduce demand characteristics compared to the original Crick manipulation. We intend to manipulate free will believes in a manner that requires no direct mention of either free will beliefs or determinism.

Free will beliefs are closely associated with perceptions of choice (Feldman, Baumeister & Wong, 2014) and relate to notions of possessing control (see studies 2 and 3 in chapter 4). Transcranial Magnetic Stimulation (TMS) is a technology that harnesses magnetic pulses to temporally (and harmlessly) interfere with the functioning of targeted brain regions. We will use TMS to impede participants motor functions while they attempt to execute a volitional action. Most ordinary people see free will as their capacity for making choices, that fulfils their desires, free from internal or external constraints Monroe and Malle (2010). Introducing an external source of control (via TMS) that constrains participants' capacity to execute volitional

choices, should therefore undermine people's sense of expressing and perhaps even possessing free will.

Haggard and Clark (2003) used TMS to induce an involuntary motor action (finger movement) while participants were preparing to execute an intentional motor action (finger movement). By pre-empting participants' volitional action via a similar, induced and unintentional action, Haggard and Clark (2003) undermined participants' implicit sense of having causal ownership over that action (finger movement) and that actions outcome (an auditory tone). Our experiment followed from this work by targeting an explicit component of agentic action control. In other words, we sought to undermine participants' conscious sense of being able to act freely towards a volitional goal.

A particular strength of this manipulation is that we are directly influencing the expression of free will in the brain. Crucially the capacity for free will is seen, by laypersons, as largely a product of the physical brain. Monroe, Dillon and Malle (2014) asked participants to rate hypothetical agents' capacities for qualities like free will and moral responsibility. The capacity for possessing free will was ascribed primarily to agents who were able to execute choices made via a physical human brain. For example, a human brain in a robot body was rated as possessing free will, as was a normal human being; by contrast, a human individual with a brain who was unable to use his thoughts to control his body was not rated as having free

will. Participants were mostly ‘‘not sure” whether a thinking robot brain within a human body had free will. In another study, participants described the circumstances under which a person could lose their free will. Consistent with the lay-person’s definition of free will, 63% cited coercion as potentially taking away free will and 40% cited brain damage (Monroe & Malle, 2014). Of course laypersons also make appraisals of their own capacity for free will. It has been demonstrated that brain related illnesses like epilepsy (that compromise a person’s ability to execute volitional actions) can reduce sufferers’ belief in the idea that people have free will (Ent & Baumeister, 2014). Additionally, Shepherd (2012) demonstrated that free will ascriptions are linked to actions that are seen as caused by conscious choices. Indeed since Benjamin Libets’ pioneering work on the unconscious neural basis of volitional actions, scientifically based explanations for free will have linked it to conscious decision making and brain states (Libet, Wright & Gleason 1982; Libet, Gleason, Wright & Pearl, 1993).

Taken together, research suggests that the physical brain, when described as an engine of choice, appears to have a central role in people’s understanding of what free will is, how it is created, executed and impaired. Concrete examples of free will interference, utilising neuroscientific methods and language (Nahmias, Coates & Kvaran, 2007) appear to offer a promising new way to manipulate participants’ perceptions of possessing and losing their free will.

In the current study, we compare the effect of our TMS manipulation (undermining participants' ability to volitionally drink water) to the Crick essay in terms of the two manipulations relative ability to undermine belief in free will. While we cannot make any firm predictions as to which manipulation will influence free will beliefs more, we expect the TMS manipulation will prove less susceptible to demand characteristics than the paradigm standard, text-based manipulation.

To further reduce demand characteristics and to enhance the effect of the manipulation we will follow the advice of Schooler (2014) by presenting the IV stimuli and dependent measures to our participants as two separate pieces of research.

Aims

1 To test a more focused manipulation of free will beliefs and compare it to the Crick essay, the paradigm standard measure.

2 To explore the paradigm standard Crick manipulation, its impact on free will beliefs and how it is understood by the participants who read it.

Hypotheses

1 Participants who have had TMS hinder a volitional action will report lower levels of perceived free will than participants in the neutral condition who have not undergone TMS.

2 Participants who have read the Crick essay will report lower levels of perceived free will than participants in the neutral condition.

3 Participants who have undergone TMS will report different levels of perceived free will than participants who have read the Crick essay.

Method

Participants

Participants were 102 UK residents (68% female M_{age} = 20.52, SD_{age} = 3.65) recruited via the University of Essex participant pool. All participants who completed both parts of the research had their data included. An additional 77 participants commenced the online pretest but did not progress to the lab session. Where participants repeated the pretest questionnaire (in order to change their timeslot), there first response was included in the data. A sensitivity power analysis showed that our sample size had 80% power to detect medium effect sizes for one way ANCOVA (f = 0.31; α = 0.05, two-tailed); mixed ANOVA (f = 0. 29, α = 0.05, two-tailed); and t tests (dz = 0. 49, α = 0.05, two-tailed).

Procedure and Materials

Online pretest and medication safety screening. Participants registered for the study by first providing informed consent to participate in ("a short social psychology questionnaire and a medical screening question for the TMS lab experiment."). participants then completed the online pre-test. This pretest was comprised of our standard questionnaire and a TMS medical screening question.

For our standard questionnaire (administered during the online pre-manipulation test and as a paper copy as the post-manipulation test) participants completed the following measures in order.

Demographics. Participants were asked to provide their gender via tick boxes, their age via a slider and their ethnic background as written text.

Belief in Free Will. We measured participants' belief that they had free will (for the online pretest) using a single-item, graphical slider scale ("Using the slider: Please indicate the extent to which you believe that you have free will."). The paper copy post-manipulation test question was identical to the pre-test, differing only in that the participants were invited to provide their level of agreement by placing a dash across the line. The scales ranged from 0 (*no belief in free will*) to 100 (*absolute belief in free will*), and the starting position of the online slider was set to the mid-point of the scale. This measure has good convergent (see Study 1) and predictive validity (e.g., Feldman, 2016), and similar single-item scales have been shown to be

sensitive to experimental manipulations of free will beliefs (McKenzie, 2014) (also see studies 2 and 3).

Opinions and beliefs. We sought to evade participant suspicion by embedding our variable of interest (free will beliefs) within a block of similar quasi-religious concepts. We did not intend to analyse these data. Participants were asked to rate their agreement to a series of questions ("I consider myself to be very religious.", "The fact that we have souls that are distinct from our material bodies is what makes humans unique.", "Human beings are an inherently spiritual race"). Participants indicated their level of agreement on a 5-point scale ranging from 1 (*strongly agree* to 5 *strongly disagree*). Participants (if willing) also provided us with their religious affiliation via a drop-down box (online pre-test) or by written text (paper copy post-test).

TMS medication screening question. Participants were then asked to provide the name of any medications that they were currently taking or to indicate that they were not currently taking medication ("Are you taking any medications? Please list below or write NO MEDICATIONS"). No participants were excluded at this stage instead any medications that were not listed on the current TMS safety screening protocol were researched prior to the lab session. Participants were fully evaluated at the lab session and if deemed unsuitable for TMS were paid in full for their participation.

Once the standard questionnaire and medication screening question had been completed participants registered online for the lab study.

Lab session

Participants completed a second informed consent form and then undertook a full TMS medical screening. If eligible to participate they then moved to the testing stage.

Testing stage. In the testing stage participants were randomly allocated into one of three conditions. Participants in the TMS condition received TMS designed to undermine their free will belief by interrupting their capacity to carry out a volitional task (drinking a glass of water).

TMS and rTMS was delivered to the primary motor cortex (M1) via a figure of 8 coil. This targeted participants' wilful control of their brachioradialis muscles and the various flexors and extensors that control the movement of the forearm, wrist and fingers. Participants were first asked which hand they typically use to drink with. Participants favoured hand was used in the experimental task with the TMS/rTMS stimulation applied to the contralateral M1 region.

Single pulse TMS was used to establish a baseline active motor threshold and to pinpoint the correct site for stimulation in the experimental stage. The primary motor cortex (M1) is typically located two thirds of the way between the front of the ear and the longitudinal fissure). Stimulation begin with the output at 50% or 1 tesla (on a magstim® Rapid 2 machine) with the participant's thumb and index finger lightly pressed together. Once the correct stimulation site was identified the active motor threshold was

established for each participant by reducing stimulator power in 5% steps until a motor response was evoked on approximately 50% of pulses.

In the experimental stage the rTMS stimulator output began at 110% of the baseline threshold established for each participant and was raised to a maximum of 130% of baseline if necessary. On each stimulation participants received 1 burst of 9 pulses at a frequency of 10 Hz (giving a total duration of 0.9 seconds). There was a minimum of 5 seconds between trials (in other words a 5 second inter train interval). These stimulation parameters lie within the recommended safe levels outlined by Rossi, et al. (2009) and Wassermann, (1998). This procedure was repeated until motor behaviour in the drinking task was suitably impeded with a maximum of 4 attempts (4 trains). Providing a maximum of 36 rTMS pulses in total.

For the volitional task participants then drank a small amount of water from a soft, shatterproof plastic cup and were given a towel to protect them from getting wet from spillage. Participants were told that data from the procedure thus far would contribute to the re calibration of the machine, supposedly necessary for the next stage of rTMS. In reality no further rTMS took place and the pause in proceedings was used to justify the completion of the dependent measures (the standardised questionnaire).

Participants in the neutral condition had an identical experience to those in the TMS condition (all instructions, screening and procedures) but,

before the TMS was due to start, were invited to fill in the standard questionnaire.

Participants in the Crick condition had an identical experience to those in the TMS condition (all instructions, screening and procedures) but before the TMS was about to start they were invited to read the Crick essay (Crick 1994) and to provide written responses to two questions ("What do you think was the main point of the essay?", "What did you think of the writing style?"). they were then invited to fill in the standard questionnaire.

In the Control and Crick conditions the initial delay in commencing with the TMS was justified by telling participants that time was needed to "calibrate and program the TMS Machine". A similar justification was given in the TMS condition after the initial (and in reality only) TMS session. These delays were provided to justify the period in which the participants completed the dependent measures (outlined below).

Dependent measures stage. Post manipulation, participants completed the post-test standard questionnaire (paper copy). While the TMS machine was supposedly being "calibrated" by the researcher. This bogus TMS calibration was displayed on a pc monitor next to the TMS machine. It took the form of a screen image similar in appearance to those on the TMS machine but with calibration equations and data input boxes.

Participants were then invited to complete the standardised questionnaire ("There is still some time so would you please complete the

second half of David's social psychology study, some of the questions may be different so please give it a fresh eye"). Participants were led to believe that the pre and post test questionnaire measures were for a different study conducted by a colleague called David who was keen to exploit the period of time left free during the lengthy TMS calibration.

Post experimental interview. Participants were then probed for any suspicion of the relationship between the IV (Crick, TMS or Neutral) and DV (post manipulation free will scores) via a post experimental interview (please see appendix 4). The nature of the participants' suspicions will also be included as they may identify the nature of the link between the IV and DV, perceived by the participants. In other words, these suspicions offer insight as to the nature of any demand characteristics that may drive findings from research utilising the Crick essays. All participants were then fully debriefed, paid and thanked.

Content Coding of the Crick essay

The primary author and an independent associate coded participants' open-ended responses to the questions regarding the point of the crick essay and its writing style. 8 categories emerged from the qualitative data after an initial read through of the first 15 responses. To be classed as '*Pro Science*' participants must interpret the essay as championing science with phrases like "showing that science has the answers". When participants interpret the essay as arguing against or disproving religious beliefs or myths (e.g. "science has

disproven religious myths" or "that religion is wrong") responses are coded as '*Anti Myth/religion*'. Claims of the nonexistence of specific aspects of mythical/religious ideologies (e.g. '*Souls', 'Afterlife', 'Free will*') were coded according to the term used, then sorted into the relevant column. '*Anti Choice or Reductionist*' understandings of the essay view it as claiming that our choices are limited or controlled by our brains, genes, environment, DNA, or some other factor (e.g "we a do don't choose as all our choices are made by our brains and neurons") these interpretations of the essay can either state that choices are constrained or just reduce human decision making down to biological neuronal processes. '*Pro Free Will*' interpretations of the essay will state that the essay was arguing that free will exists.

Finally, Interpretations of the essay that mention free will but do not claim that the essay was arguing in favour or against it, should be coded as '*Free Will Neutral*' (see appendix 5 for coding instructions).

Results and Discussion

Crick condition essay coding

Table1. *Content coding of participants understanding of the Crick essay.*

Coding category	Percentage Coder Agreement	Kappa of agreement	Percentage of participants mentioning the category
Pro Science	91	.77	20.6
Anti Myth or Religion	94	.82	23.5
Anti Soul	97	.93	32.4
Anti Free will	88	.72	23.5
Anti Afterlife	100	1	2.9
Anti Choice or Reductionist	88	.74	32.4
Pro Free Will	100	1	2.9
Free will neutral	100	1	11.8

Category coding instructions are included in appendix 5

Table I demonstrates that 23% of Participants reading the Crick essay viewed the essay's principle focus as undermining free will, compared to 32% who saw the essay as a challenge to the idea of a soul. It is possible that participants who interpreted the essay as undermining the idea of the soul

concluded from that that there must also be no free will. However, Monroe et al., (2014) demonstrated that hypothetical agents can be judged as possessing free will even in the absence of a soul. The notions of the soul and free will do not appear to be strongly related. What seems clear is that the Crick essay is not a focused manipulation of free will beliefs and a more focused manipulation should be developed.

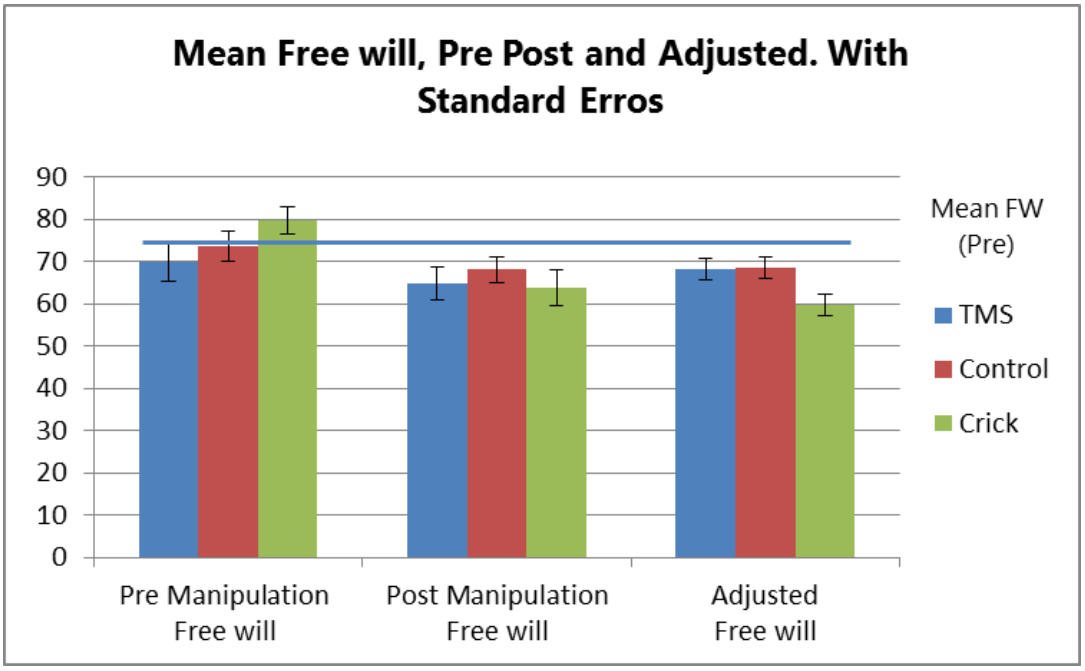
Suspicion and demand characteristics. The post experimental interview revealed that 11 (32%) of participants reading the Crick essay were suspicious overall with 6 (18. %) people thinking that the study was about free will, 4 (12 %) thinking it was about the soul and 1 (3 %) concluding that the experiment was something to do with the essay. This was despite the TMS session/Crick essay and dependent measures being presented as parts of (apparently) separate studies; although the act of probing may have encouraged suspicion. This finding supports the argument that demand characteristics may play a non-trivial role in findings where the Crick essay is used as a manipulation.

We next checked for suspicion concerning the link between the manipulation and the dependent measure (post manipulation free will scores) for all three conditions. The post experimental interview revealed that for participants reading the Crick essay, 6 out of the 34 (17.6%) of participants successfully identified the link with free will Compared to 3 (8.8%) in the TMS condition and 2 (5.9%) in the control condition. The TMS manipulation is less

prone to demand characteristics than the Crick essay even when the manipulation and dependent measures are presented to participants as two separate studies. To summarize, the Crick manipulation lacks focus and is laden with demand characteristics even when participants believe that the manipulation and dependent measures are separate studies (although this may not hold true when participants are not probed for suspicion).

Main analysis

Figure 1. *Pre Manipulation, Post Manipulation and Adjusted free will scores with Error bars. Blue line represents the overall mean Pre Manipulation Free will (covariate).*



While testing for the assumptions of ANCOVA we checked whether there were any significant differences between our 3 conditions pre-manipulation free will scores.

A one-way ANOVA revealed no significant differences between the three conditions pre manipulation free will scores $F(2,99)=1.76$, $p= .178$ but there was a near significant difference between the TMS and Crick conditions $t(66)=-1.83$ $p=.07$

We then conducted our main analysis, testing our three hypotheses by conducting a one way ANCOVA, with pre manipulation free will scores as a covariate. This revealed a significant main effect of condition on post manipulation free will beliefs, $F(2,98) = 3.84$, $p=.025$, partial $\eta^2 =.07$.

Planned contrasts revealed that, controlling for the covariate, participants in the Crick condition reported significantly lower belief in free will, following the manipulation, than participants in the Neutral condition. $t(98) = -2.46$, $p=.01$. By contrast, undergoing TMS did not result in significantly lower belief in free will compared to the Neutral condition $t(98) = -0.08$, $p=.93$, $r =.008$.

A post hoc analysis was conducted with a Bonferroni adjustment made for the number of comparisons. There were no significant differences between the Crick and TMS conditions adjusted free will belief scores $SE=3.66$ $p=.06$.

It appears then, that the main effect of condition (observed in the ANCOVA) was significant due chiefly to a post manipulation (adjusted mean)

difference between the TMS and Crick conditions. Hypothesis 2 was supported in that participants who read the Crick essay reported significantly lower levels of belief in free will than participants in the Neutral condition. Hypotheses 1 and 3 were not supported in that the TMS manipulation did not result in significantly lower free will belief, compared to the Neutral condition and free will beliefs did not differ significantly between the TMS and Crick conditions.

Additional Analysis

Figure 1 demonstrates that the post manipulation free will scores were lower than the pre manipulation scores for all three conditions including the control condition. We decided to investigate this within condition reduction in order better understand the TMS manipulations failure to significantly lower the adjusted post manipulation free will scores, compared to the neutral condition.

We first conducted a mixed ANOVA on free will scores with time point (pre and post manipulation) as the repeated measures factor, and condition as the between subjects factor. This revealed a significant main effect of time point, F (1,99) = 32; $p < .001$), and a significant interaction between time point and condition, F (2,99) = 5.29; $p < .001$. We followed this up with t-tests for each condition, which revealed that participants in the TMS condition $t(33) = 3.06$, $p = .004$, $r = .47$, the Control condition $t(33) = 2.57$, $p = .015$, $r = .41$, and the Crick condition. $t(33) = 4.18$, $p < .001$, $r = .59$, all reported significantly

reduced levels of post manipulation belief in free will, compared to their pre manipulation scores. For all conditions there was a statistically significant reduction in free will beliefs. The interaction appears to be driven by a greater increase in the reduction of free will beliefs in the Crick condition compared to the other two conditions.

Discussion

Our qualitative analysis found that the Crick manipulation lacks focus and may prompt demand characteristics. Regarding the quantitative data, the pre manipulation free will scores were not significantly different between the three groups. The ANCOVA revealed significantly lower free will scores for the Crick manipulation compared to the Neutral condition (when controlling for pre manipulation free will scores). Finally, exploratory *t* tests demonstrated statistically significant drops in free will belief between pre and post manipulation scores, for all three conditions.

As such, although the ANCOVA revealed that only the Crick group showed significantly reduced free will in comparison to the control group, all three groups (including the control group) showed significant reductions in free will. What might have caused this reduction in free will? In the subsequent sections we discuss three possible explanations for this drop. Specifically we explore (i) the potential impact of group differences in free will

belief prior to the manipulation, (ii) the possibility that these drops reflect normal fluctuations in free will scores between the two sessions, and (iii) the possibility that the intimidating lab environment, and the prospect of TMS was enough to lead to a reduction in free will belief.

Firstly, although there was no significant difference in free will beliefs between the different groups prior to the manipulation, we cannot rule out that the higher levels observed in the crick condition did not impact our findings. These somewhat higher pre manipulation scores in the Crick condition, would have left more room for potential reduction, either through genuine change, or through regression to the mean. Further research could investigate this possibility with a larger sample to reduce any potential group allocation bias.

To explore the second possibility, namely whether the significant reductions observed for all three conditions, between pre and post manipulation free will scores were due to normal, daily fluctuations, or test re test effects, we looked back at our data from study 3. For the current study the average duration in days between participants' online pre-test and their post manipulation lab test varied according to lab/participant availability ($M_{duration}$ = 7.39, $SD_{duration}$ = 11.456). Study 3 (diary study) tested daily fluctuations in free will beliefs over a 2 week period using a similar single item graphical slider. Although free will beliefs fluctuated over time, t test analyses of all 7 possible one week test re test delay comparisons, demonstrated no

statistically significant differences (between days 1 and 8, days 2 and 9, days 3 and 10 etcetera). As such, it is unlikely that either test re test effects or daily fluctuations could account for the significant reduction between pre and post manipulation free will beliefs, observed for all three conditions in the present study.

Instead, perhaps simply being in an intimidating lab environment, surrounded by very imposing TMS equipment, feeling nervous and wishing to leave but feeling unable to (although note that participants were of course free to withdraw at any point), made participants feel constrained and less free. Evidence in support of this possibility comes from other studies where constraining or otherwise intimidating situations may have played a factor in undermining free will belief. For example, (Ent, 2013) evoked an involuntary eye blink responses from participants' by directing puffs of air into their eyes with a bulb syringe. The researcher then triggered the pupillary reflexes of these participants by shining a penlight on the outside corner of each eye, then in between the eyes. These participants subsequently reported lower belief in free will than participants who simply executed a voluntary response by bouncing a ball between their dominant and non-dominant hands. This relationship was only observed for individuals low in trait reactance. Reactance (Brehm 1966; Miron & Brehm, 2006) is a person's drive to resist perceived threats to their sense of being a free agent, able to behave as they choose. It could be that participants low in trait reactance (and therefore not

resistant to having their sense of freedom challenged) felt constrained and potentially intimidated in the involuntary eye blink condition. This may have driven their reduced perception of having free will relative to the voluntary response condition.

Similarly, Laurene et al., (2011) reported lower endorsement of free will beliefs for incarcerated adolescents compared to non-incarcerated adolescents. These two studies combined with the knowledge that free will beliefs are essentially rooted in an individual's sense of possessing choice and being free from constraints (Monroe & Malle, 2010; 2014; Study 1), suggest that placing participants in constraining, intimidating situations, where they feel that their choices are limited, may impact there sense of being free. This may reduce their endorsement of free will beliefs.

Returning to the present study, it is possible that the intimidating lab environment reduced participants' sense of feeling in control and free. Such an effect may have been more pronounced in the Neutral and Crick conditions where participants completed their free will self-report dependent measures while still waiting (or so they believed) to undergo TMS, a potentially highly intimidating procedure. By contrast, in the TMS condition, the free will self-report was filled in after the first round of TMS and rTMS had been administered. Expressions of relief at discovering that the rTMS procedure was no big deal were observable on the faces of most participants as they sat and filled in there self-reported free will belief measure. Many

participants stated that the procedure (TMS and rTMS) had been far less scary than they expected. It seems plausible that the intimidating effect of awaiting TMS impacted participants to a greater extent in the Crick and Neutral condition than it did in the TMS condition. Further research could look to harness this type of setup against a more suitable control condition to confirm or discount these possible interpretations.

Conclusions and suggestions for future research

Of course, the only firm conclusion we can draw from the findings of the present study is that participants reading the Crick essay reported significantly lower belief in free will than Participants' in the neutral condition (after controlling for pre manipulation free will scores), whereas participants undergoing the TMS manipulation failed to do so. It may simply be that the TMS manipulation was not successful at undermining participants' belief in free will.

Future studies should be mindful that placing participants in a stressful situation that makes them feel nervous and constrained may undermine their sense of having choice/control and possessing free will. This could be confounding in studies seeking to manipulate belief in free will. Future research could test for this potential effect and if established, should control for or perhaps exploit the impact of constraining participants' perceived choices/control (via stress inducing situations), as a potential new manipulation of free will beliefs.

Our qualitative analysis of the Crick manipulation, confirmed that it lacks focus and potentially influences free will through demand characteristics. Here we attempted to develop a more focused, harder hitting manipulation to undermine free will beliefs without the demand characteristics inherent to the Crick essay. Future research could extend this by developing stress based manipulations that can be used online, facilitating both a test retest measure of free will beliefs and allow for a larger sample size to reduce group allocation bias, and increase the reliability of the effect sizes obtained.

Next step

Study 1 confirmed that lay participants see free will as essentially their capacity to make unconstrained choices (Monroe & Malle, 2010; 2014, studys 1 and 3). Studies 2 and 3 established that peoples' sense of possessing choice and control underpins the documented relationship between free will beliefs and subjective wellbeing (Crescioni et al., 2015). As pro deterministic/anti free will messages can undermine free will beliefs, we reasoned that these manipulations may also impact perceived control and subsequently indicators of subjective wellbeing. Chapter 5 established that a modified (shortened) version of the Crick essay could impact perceived control. This modified version was still broad and prone to demand characteristics. A new manipulation was needed. Study 6 demonstrated that although our TMS manipulation failed to undermine post manipulation free will beliefs (relative to the control condition) it did result in a significant drop between participants' pre and post manipulation free will scores. In chapter 7 we aim to create a second new manipulation and see if it can modulate behaviour and undermine participants' perceptions of being able to achieve life outcomes, by impacting their perceptions of having control.

Chapter 7

Study 7

Belief in hard determinism and its impact on perceptions of free will, control and self-efficacy and behaviour.

Abstract

Having confirmed that choice capacity is central to lay understandings of free will and establishing that perceived choice/control underpins the relationship between belief in free will and subjective well-being we wanted to see if anti-free will manipulations could impact perceptions relevant to life outcomes, via perceived choice/control. In chapter 5 study 5 a modified version of the Crick essay successfully impacted perceptions of choice relevant to having control over one's actions and decisions. In the current study we devised a new manipulator, consisting of a video showing a series of pictures and clips, with either a deterministic, or non-deterministic voice over. We aimed to see whether our new stimuli could impact perceptions of free will, self-efficacy and notions of control relative to both control over one's decisions/actions and control over one's life outcomes. This new manipulation successfully undermined belief in free will (despite never mentioning it) but failed to impact the other variables. An exploratory path analysis demonstrated that

when participants disagree with the deterministic video, they report higher levels of self-efficacy, indirectly via perceived control (demonstrating probable reactance effects). When they agree with the deterministic video, they report reduced self-efficacy via perceived control. We also offered participants an opportunity to cheat by falsely claiming to have heard of a fictional organisation in order to avoid completing a short written task. Surprisingly participants exposed to the non-deterministic lecture cheated more than participants exposed to the pro deterministic lecture. Theoretical explanations for these findings are then discussed and suggestions made for future research.

Introduction

Broadly speaking research into free will falls into three main areas. The first strand of research seeks to manipulate free will beliefs in order to impact socially relevant behaviour (Vohs & Schooler, 2008; Baumeister et al., 2009). The Vohs and Schooler (2008) results, whereby participants were induced to increase cheating behaviour through reading sentences or passages undermining free will, have often thwarted attempted replication (Giner-Sorolla et al., 2015; Nadelhoffer, Shepard, Crone, Everett, Earp & Levy, 2019). Given the extensive use of text-based manipulations in previous research, the video manipulation created in the current study will follow some aspects of

these manipulators, while attempting to overcome some of their inherent problems (discussed in detail below).

The second strand of free will research has proven more robust than the attempts to impact socially relevant behaviours by manipulating belief in free will. This second strand harnesses qualitative and correlation-based approaches in order to explore how people understand freely willed actions and the utility of free will beliefs to predict other psychological phenomena and life outcomes. For example, the ability to act freely has been linked to conscious decision making (Sheperd, 2012), and autobiographical narratives link free actions to moral behaviour, achieving goals, and high levels of conscious thought and deliberation (Stillman et al., 2011). Free will beliefs positively predict academic performance (Feldman et al., 2016) higher self-reported life satisfaction, meaning in life and subjective happiness, self-efficacy and reduced perceived life stress (Crescioni et al., 2015). Free will beliefs are linked to notions of moral accountability, predicting attitudes toward punishment (Rakos et al., 2008). Reading about others immoral behaviour has been shown to increase free will beliefs, mediated by the desire to punish. (Clark et al., 2014). Perceived choice plays a pivotal role as blame judgments appear to draw primarily from a belief that the agent had a choice, acted intentionally and was the sole cause of their actions, rather than a belief that the agent had free will (Monroe, Dillon & Malle, 2014). The relationships between free will, moral responsibility and life outcomes appears to draw

upon overlap between free will and perceptions of choice and control (see Monroe, Dillon & Malle, 2014: Monroe, Brady, Malle 2016; and studies 2 and 3 of chapter 4).

The third strand debates the nature of free will and in doing so sets the requirements for its existence. Some scientists embrace a definition of free will drawn from philosophical debates. This definition sees free will as a property of the human soul or consciousness that is able to make choices immune to the causal influences of past events or the current processing of the biological brain. Because this version of free will appears to be at odds with scientific understandings many researchers have become skeptical of its existence (Cashmore, 2010; Greene & Cohen, 2004). Some, like Harris (2012), have become almost evangelical about spreading an anti-free will gospel to packed theatres full of enthusiastic disbelievers (Harris 2013). This understanding of free will, drawn from the philosophical tradition, runs contrary to the definition employed by the vast majority of laypersons who view free will as simply their capacity for choice that fulfils their desires, free from internal or external constraints. (Monroe & Malle, 2010; Monroe, Dillon & Malle, 2014) also see study 1 (chapter 3) and study 3 (chapter 4). These two competing definitions have led to considerable confusion in the current research when free will, as operationalised by scientists in the form of broad ranging manipulations and multiple item measures (see chapter 2), are contrasted with the understandings of participants, who simply see free will as their capacity

to make unconstrained choices (Monroe & Malle, 2010). This complexity has been greatly exacerbated by many researchers' assumption that lay participants see free will and determinism as incompatible (see chapter 2 and chapter 3 study 1). These issues have added to the general challenges inherent to research of this type. These challenges warrant addressing.

Key issues to address

The current research aims to address two key theoretical and methodological issues that we feel have been largely overlooked in the current literature. These involve demand characteristics and the multifaceted nature of manipulations.

Demand characteristics. Much of the research in this area harnesses the Crick essay to undermine belief in free will (Crick, 1994). By explicitly stating that free will does not exist the Crick essay alerts participants to the intentions of the manipulation, introducing the potential for a complex interchange between demand characteristics and manipulation effects. The current study will not employ any mention of free will and will seek to minimise any overlap between the language used in the manipulations and the language used in the dependent measures.

Multi-faceted manipulations. The Crick essay also contains attacks on the idea of religion and notions of the soul and afterlife; notions tangential but not essential to understandings of free will and determinism. Anti-religious claims might impact participants differently than claims about pure

determinism, thus introducing a second manipulator. Anti-religious claims should therefore be excluded. Similarly, Crick's use of high concept ideas explained with low frequency language should be replaced with a more down to earth style, aimed at maximising understanding and minimising intimidation. The key elements to include are those fundamental to the deterministic accounts espoused by most modern commentators, as this will provide ecological validity and mirror people's real experiences of exposure to and engagement with, deterministic thinking. The current study will attempt to create a new more focused manipulation that, in tandem with our experimental design, minimises demand characteristics.

Building a better manipulation of determinism. When building our new manipulation of deterministic (and perhaps free will) beliefs, we decided to revaluate the process from the ground up with an eye to the strengths and weaknesses of the current manipulations. It was felt that a video with a voice-over would be the most engaging and accessible medium to communicate interesting yet oftentimes intimidating deterministic arguments.

Study 1 measured cheating by inviting participants to provide marketing feedback to a fictional organisation or be dishonest by claiming to have already heard of them. Although there were issues with the design of the experiment that made an analysis of cheating inappropriate, it still yielded valuable cheating data.

Of the 61 participants for whom we received response data, 18 (29.5%) cheated. 34 (55.7%) did not cheat and 9 (14.8%) gave non appropriate answers that could not be coded as cheating or non cheating. There were no signs of participant suspicion. With a baseline cheating rate of approximately 30% this appears to be a practical and subtle method of measuring participants' tendencies to cheat by being dishonest.

Also as part of study 1, we validated our two new single item slider measures of free will and scientific determinism by comparing them to the already well validated free will and scientific determinism subscales of the FAD-Plus (Paulhus & Carey, 2011). These comparisons provided evidence that our single item slider measures were targeting their desired constructs. Participants did not see free will and determinism as incompatible when responding to our single item measures, but a modest relationship was observed between our single item measure of lay free will and scientific determinism -.236 (p=.02) as measured by the FAD-Pluss.

As discussed extensively in chapter 2 the assumption of lay incompatibility permeates much of the current research and assumes that a change in one variable (perhaps free will) reliably equates to an equal and opposite change in the other (scientific determinism). As discussed above, the Crick Essay, an often used free will manipulation, appears to touch on free will and determinism, as well as religion. Here we aim to overcome this by focusing on only determinism. By deliberately targeting and promoting only belief in

determinism and recording the impact on free will beliefs we will be able to measure the extent to which participants see hard determinism and lay concepts of free will as incompatible. This approach will reduce the likelihood for potential demand characteristics that occurs when manipulations state that free will does not exist and then askes participants about the existence of free will, as a dependent measure.

In studies 4 and 5 we assessed the extent to which the Crick essay can be used to manipulate different measures of control. In Study 4, this manipulation failed to influence our measure of Mastery and Constraints (Chou and Parmer, 2016); a measure of control that draws upon participants' sense of being able to achieve goals while being free from constraints. In contrast, study 5 showed Author of Actions; a measure of control that likely probes participants' sense of having control over their actions, decisions and life choices, was undermined by reading the Crick essay. For the current study we will endeavor to build a pro determinism manipulator that can impact, free will, both forms of control and influence an indicator of participants perceptions of being able to achieve important life outcomes. One possible candidate would be participants perception of self-efficacy (Bandura 1977)

Self-efficacy. Perceived self-efficacy is concerned with judgments of how well one can execute courses of action required to deal with prospective situations (Bandura 1982). It involves "beliefs in one's capabilities to mobilize the motivation, cognitive resources, and courses of action needed to meet

given situational demands" (Wood & Bandura, 1989, p. 408). Factors such as levels of perseverance with a difficult task, levels of effort invested, and even weather challenges are undertaken, can all depend on the individual's perceptions of personal self-efficacy for that particular task. The notion of General self-efficacy is more trait like, describing an individual's perceptions of themselves as able to bring about positive outcomes across a variety of often work based domains (Judge, Erez & Bono, 1998; Chen, Gully & Eden, 2001),

Self-efficacy is an ideal dependent measure with real-world utility for predicting positive health outcomes (Conner & Sparks, 2005) and educational attainment (Bandura, Barbaranelli, Caprara & Pastorelli, 1996). Crucially self-efficacy also has a lack of conceptual overlap with determinism. That is to say determinism, when understood properly, lacks any implications for self-efficacy, as an individual's capacity to achieve goals is not increased or decreased according to a deterministic account; it is simply set. According to determinism the universe will unfold in a predetermined fashion, with the individual predetermined to succeed or fail at a given task. The effort they make and the talents they have are predetermined to be either adequate or inadequate in terms of achieving that task. Determinism does not add or detract from the individuals' ability to achieve goals. A failure to fully understand this is required for participants to view determinism as blocking/limiting their capacity to execute choices and influence life outcomes. Educational level may moderate the impact of the manipulation on

the dependent measures, with better educated participants potentially more able to comprehend determinisms lack of real implications. Alternatively, better educated individuals may better understand the deterministic argument, increasing the impact of the manipulation. We therefor make no prediction for the direction of this effect. The lack of true conceptual overlap between determinism and self-efficacy facilitates the use of a multi item measure of self-efficacy, whose wording has no obvious overlap with the language used in the deterministic manipulation itself. This should minimize demand characteristics.

Chapter 4 demonstrated across two studies that the capacity for free will beliefs to predict life outcomes is due to free will beliefs being primarily based on perceptions of having choice and control. Study 2 demonstrated that when entered simultaneously into a multiple regression, sense of personal control (mastery and constraints) better predicted satisfaction with life and perceived stress than free will beliefs, and emerged as the only significant predictor. In the daily diary study (study 3) sense of personal choice and control (slider measures), better predicted daily stress and daily depression than Free will beliefs. The rational for these 2 studies was based on findings of Monroe et al. (2017) who demonstrated that perceived choice capacity not free will beliefs underpinned ascriptions of moral responsibility for a hypothetical agent who committed an immoral act.

For the current study we therefore predict that both forms of personal control (see studies 4 and 5) will better mediate the impact of experimental condition on self-efficacy than our measure of free will beliefs. But what form should an enhanced deterministic manipulation take? What can we draw from the Crick essays? What should we discard and what should we add to build a deterministic manipulation that encapsulates the contemporary understanding of determinism and could influence perceptions key to personal achievement in the real world?

Study 6 explored the relative utility of the Crick essay to undermine belief in free will compared to a new TMS manipulation. Participants also provided information on their understanding of what the main message of the Crick essay was. 32.4% responded in a manner that sees the Crick essay as arguing that our choices are limited or controlled by our brains, genes, environment, DNA, or some other factor, 32.4% viewed Crick as a challenge to the idea of a soul and 23.5% viewed it as primarily an attempt to undermine free will. Importantly the Crick essay manipulation incorporates both anti free will and pro determinism elements. The video lecture on determinism that we created specifically for this current study, is pro determinism and does not include any statements denying the existence of free will. It is a pro determinism manipulation not an anti free will manipulation.

The video lecture includes the following elements from the Crick essay and modern accounts of determinism.

- A Mechanical cause and effect model of the universe from the big bang until now.
- Reductionism of all thoughts and feelings to brain processing.
- Brain self/consciousness dualism.
- Brain chooses then generates you (your conscious self), a causal order argument.
- Brain scans can predict our choices before we know them.
- Brain decisions can be controlled by scientists without participant awareness.
- Conscious choice is an illusion.
- Your future is set and predetermined; you cannot change it.

The video lecture on determinism will exclude the following potential confounds inherent in the Crick (1994) essay.

- Low frequency intimidating language.
- Claims of no afterlife.
- Religion is wrong and for the uneducated.
- Souls do not exist.
- We are pro science and anti-myth.
- Any direct references of free will that promote demand characteristics and prevent testing for participant Incompatibilism.

Determinism condition

The final script will focus on the key conceptual elements of the Crick essay for modulating determinism (see appendix 6). The script will be narrated over a series of visual images by a reader that is not observable on the video. The script described the participants' feelings, thoughts and choices as merely products of cause and effect processes that started at the big bang and progressed inexorably until now. It explains that ultimately all our decisions and future life outcomes are fixed and inevitable. We, as in our consciousness, do not actually make decisions. Rather our brain (described in terms of an external causal agent) makes all of our decisions for us and then imposes them on us. Brains are solely the product of the predetermined interactions of physical atoms meaning that the decisions they make are also predetermined. The brains decisions can be predicted and even influenced by modern science.

Mindful of Schooler's (2014) attempt to ensure that participants were aware of the eminence of the scientists quoted, we referenced the work of the same eminent scientists in both conditions. Including a reference to Albert Einstein a scientist whose stature is universally recognised.

Neutral/non-deterministic condition.

The control condition presents a non-deterministic account. It used the same visual feed as the determinism video but had a different narrated content. The non-deterministic script (appendix 6) describes the achievements of modern

science in crafting theories that unravel the mysteries of the universe and the human brain. It goes on to outline the hard problem of human consciousness, wondering if science will solve it. It is scientific, explaining how science is steadily adding to our knowledge of how the brain came to be but does not champion hard determinism in relation to consciousness. Table 0 shows the main elements of the deterministic video lecture and how the non-deterministic consciousness video lecture differs.

Table 0. *The contrasting themes covered in the deterministic and consciousness videos.*

Determinism	Consciousness
Mechanical causation from the big bang until now, including all mental processing and conscious thought in the past present and future.	Mechanical causation is explained for physical objects only. Deterministic causation is not applied to mental processes related to consciousness. The hard problem of consciousness is explained as a challenge that science aims to tackle, but may never solve.
Reductionism of all human experiences, thoughts and feelings to brain processing.	Explains brain processing's relevance to memory and decision making but not all human experience. Brain processing

	contributes to consciousness, but a mystery remains.
Brain self/consciousness dualism. We are our consciousness but are brains are separate and in charge.	We have conscious awareness; we are not a separate consciousness.
The brain chooses and only then generates consciousness in a causal, temporal hierarchy.	Our brains contribute to consciousness but no causal order between brain and self is implied. There is no delay between brain processing and experience.
Brain scans can predict choices.	Neutral: not covered
Brain decisions can be controlled without participant awareness.	Neutral: not covered
Conscious choice is an illusion.	Neutral:
Your future is set and predetermined.	Neutral: not covered

Aims

This current study has 3 main aims. 1) To construct an enhanced manipulation of belief in determinism that addresses some of the theoretical and practical limitations of the stimuli typically used. 2) To see if that manipulation can undermine people's perceptions of having free will control and self-efficacy and potentially even encourage cheating. 3) To establish that an individual's sense of perceived control better mediates the impact of determinism on perceived self-efficacy than their free will beliefs. In carrying out these aims we will attempt to address several key issues currently limiting work in this field and draw on the findings from studies 1-6.

Hypotheses

H1 Participants exposed to a deterministic argument will report lower perceived self-efficacy than participants watching the consciousness video.

H2 Participants exposed to a deterministic argument will report lower belief in free will than participants watching the consciousness video.

H3 Participants exposed to a deterministic argument will report lower belief in Control (Mastery and Constraints) than participants watching the consciousness video.

H4 Participants exposed to a deterministic argument will report lower perceived Control (Author of Actions) than participants watching the consciousness video.

H5 The measures of Control (Mastery/Constraints and Author of Actions) will better mediate the relationship between experimental condition and perceived self-efficacy than free will beliefs.

H6 a) The relationship between experimental condition and each of the 4 outcome variables (as tested in hypotheses 1-4) will be moderated by participants' Agreements with the lecture, with relatively high agreement predicting lower levels of all 4 criterion variables for participants in the deterministic condition.

H6 b) The relationship between experimental condition and each of the 4 outcome variables (as tested in hypotheses 1-4) will be moderated by participants' educational level (2 tailed). This hypothesis is bidirectional as It is not known whether participants with a relatively high education will be more likely to accept the deterministic message or feel more confident to reject it.

H7 Participants exposed to a deterministic argument will cheat as often as those in a control condition.

H8 If (contrary to the prediction of hypothesis 7) participants in the determinism condition cheat at a higher level than participants in the control condition, perceptions of control will better mediate the relationship between experimental condition and cheating than free will beliefs.

Method

Participants

Participants were 213 U.S. residents recruited through the MTurk web service (55% male; M_{age} = 40.31, SD_{age} = 11.08). 154 additional participants were excluded because of duplicate IP addresses (n = 9), failing basic attention check items (n = 4), failing to watch the entire video (n=32), failing to complete at least 90% of the questionnaire (n=30). Failing to answer the task engagement question correctly by identifying the general argument presented in the video (n=45), participated in the research on a device with a screen smaller than 10-inch (n=34). A sensitivity power analysis showed that our sample size had 80% power to detect "small to medium" effect sizes for independent samples t-tests (d = 0. 38, α = 0.05, two-tailed); moderation analysis (f2 = 0.04, α = 0.05, two-tailed); and Binary logistic regressions (w = 0.19, α = 0.05, two-tailed).

Procedure and Materials

Participants completed the following measures in order. The first two measures listed below (determinism/free will manipulation) participants were randomly assigned into one of the two experimental conditions:

Determinism/free will manipulation. Participants were presented with either a neutral non-deterministic, voice-over video lecture about scientific progress into understanding consciousness or a deterministic video

lecture championing the idea that everything, including our choices and thoughts are all pre-determined.

The deterministic video was designed to include the following pro determinism elements (inherent in the original Crick Manipulation): Neuro reductionist arguments that reduce all human thoughts, choices and feelings down to processing in the brain. Arguments that suggest that our choices are predetermined by our brain. Arguments that promote a dualistic relationship between us (our consciousness) and the brain. Claims that unconscious processes make our decisions for us. We decided to exclude any potentially confounding elements of the Crick essay such as arguments that seek to undermine religious notions of the afterlife, the soul and any direct mention of free will.

The following elements will be included as they are inherent to many accounts of determinism (see Harris 2013 for an example of some of them). Our choices are predetermined by mechanical causation from the big bang until now. Brain self/consciousness dualism suggesting that we are our consciousness, our brain is external to the self and exerts control over us. Our Brain's decisions can be controlled without our awareness. Statements that conscious choice is an illusion. Arguments that our future is set and fixed.

It has been argued that the inclusion of biographical information that emphasises the academic status of Frances Crick increased the impact of the stimuli on participants' free will evaluations and moral behaviours (Schooler

2014). We therefore make reference to the eminent scientists whose research we cover in our video lectures and included references to Albert Einstein in both videos, a scientist whose eminence is well known.

The non-deterministic control condition will echo the topic of the paradigm standard Crick text (Vohs & Schooler 2008) by addressing the challenges inherent to the study of consciousness. The control condition will use exactly the same video as the deterministic condition (apart from the caption by Albert Einstein espousing his engagement with the subject matter) but will have a different narrated script.

The consciousness video outlines scientists' ability to investigate our universe and highlights some successes, before explaining the challenges of addressing the hard problem of consciousness. It avoids agreeing with or disputing any of the deterministic conclusions made in the pro determinism video remaining neutral on the subject by suggesting that the hard problem of consciousness may not be solved.

Both videos are matched for length and sound quality and utilise identical visual tracks with the exception of a caption referring to Albert Einstein's positive endorsement of the subject matter that differs by condition. Before being presented with the passage, participants were advised that they should listen carefully to the lecture because they would be asked to provide a later summary of its subject.

Links to the video lectures are below.

Deterministic video = https://youtu.be/T1zomfUuFyY

Non deterministic, consciousness video = https://youtu.be/1Gjp5NjSPS4

Participants then completed the following measures in order, starting with the three measures likely to represent the Lowest demand characteristics:

Self Efficacy. Participants' sense of confidence in being able to achieve lifegoals was assessed using the New General Self-Efficacy Scale (Chen, Gully & Eden, 2001) The NGSE is comprised of 8 items designed to measure non-specific aspects of life satisfaction (e.g.," In general, I think that I can obtain outcomes that are important to me"; "I believe I can succeed at most any endeavour to which I set my mind"). This scale represents a single factor. Is highly related to yet distinct from self-esteem measuring a construct related to motivational factors across work contexts. The NGSE has high Content validity with 97% of items sorted as representing general self-efficacy in a validation study and superior predictive validity to some similar instruments. Importantly the individual items in this scale do not use wording that echoes any of the assertions put forward in either video. This was intended to reduce potential demand characteristics.

Belief in Free Will. We measured participants' belief that they had free will using the same single-item, graphical slider scale used in study 6 ("Using the slider: Please indicate the extent to which you believe that you have free

will."). The scales ranged from 0 (*No belief in free will*) to 100 (*Absolute belief in free will*), and the starting position of the online slider was set to the mid-point of the scale. This measure has good convergent (see Study 1) and predictive validity (e.g., Feldman, 2016), and similar single-item scales have been shown to be sensitive to experimental manipulations of free will beliefs (McKenzie, 2014).

Control (**Mastery and Constraints**). Participant's sense of having control in the form of personal mastery and freedom from constraints was measured using the same items as study 3. On this occasion participants indicated their level of agreement on a 5-point scale ranging from 1 (*Strongly disagree*) to 5 (*Strongly agree*) with higher scores indicating a greater sense of control (3 items were reverse coded). This 1-5 scaling echoes Lachman and Weaver (1998) original use of the unmodified the scale and offers more reliable/consistent presentation during online research.

Control **(Author of Actions)**. Participants sense of being the true author of their actions and possessing control over their decisions was identical to study 4 with the only change made, a reduction of the number of scale points. This was done to ensure a better quality of presentation to participants testing online. For each question participants indicated their level of agreement on a 5-point scale ranging from 1 (*Not at all*) to 5 (*Entirely*) with all other scale-points represented only numerically. Higher scores indicated a greater sense of control.

Demographics. Participants were asked to report their gender and age.

Educational level. Participants were asked to report their educational level via an 11-item multiple choice question.

Task Engagement. To ensure that the video had been watched and comprehended, participants were asked to read four sentences and identify the one that summarised the content of their video.

Agreement with argument (Moderator): To tap into participants pre-existing beliefs and potentially identify resistance to the manipulation. Participant's reported their level of agreement with the video via a single-item, graphical slider scale ("Using the slider: Please indicate the extent to which you agree with the argument presented in the video"). The scale ranged from 0 (*Completely Disagree*) to 100 (*Completely Agree*) and the starting position of the online slider was set to the mid-point of the scale.

Cheating opportunity. Participants were then given an opportunity to cheat by making a demonstrably false claim. This was an identical cheating task to study 1 except the name of the fictional institution was made even more obscure. The task instructions read "This research has been sponsored by the Moamrasilia Trust. If you had not previously heard of the Moamrasilia Trust please give us 2 or 3 sentences describing how you feel we might better share our research findings with members of the public like you. OR If you

had previously heard of the Moamrasilia Trust please just simply write the words 'I had heard' in the box below".

The name Moamrasilia Trust was fictional (no similarly named organisation appeared on internet searches). Participants who responded "have heard" were therefore coded as cheating.

***Outliers and exclusions**:* Participants will be excluded if they fail to meet one of the following: 1 Failing to correctly answer the attention check questions in the Likert measures. 2 Failing to watch the whole of the video (as indicated by the Qualtrics timing questions). 3 Failing to complete at least 90% of the questionnaire. 4 Failing to answer the task engagement question correctly by identifying the general argument presented in the video. 5 Suspected repeated participation in the experiment (as indicated by repeated IP addresses). 6 failure to participate in the research on a required device ("a Full PC or full Mac with a 10-inch screen or larger, no phones please").

Planned analysis

In step 1, assuming the assumptions are met, a series of independent samples *t*-tests will compare the effects of experimental condition on participants' self-reported Self-efficacy (H1), Free will beliefs (H2), Control (Mastery and Constraints) (H3) and Control (Author of Actions) (H4).

Step 2 will test H5. Path analysis will be used to confirm that perceived Control (both measures) better mediates the effect of condition on Self-efficacy than Free will beliefs.

Step 3 will test H6 (a,b). Linear regression will be used to explore whether the effects of condition on Free will, Control (Mastery and Constraints), Control (Author of Actions) and Self-efficacy, are moderated by either participants' Agreement with the video lecture or their Educational level.

Step 4 will test hypothesis 7. Logistic regression and Bayesian equivalence testing will be used to explore any impact of experimental condition on cheating (a two tailed hypothesis). If (contrary to hypothesis 7) experimental condition modulates cheating behaviour, hypothesis 8 will then be tested, with path analysis used to confirm that the relationship between condition and cheating behaviour is better mediated by perceived control than free will beliefs.

Results

Table 1 presents descriptive statistics. Table 2 presents, correlations and alpha reliabilities among the measures. As expected, all measures correlated significantly and positively. Table 3 presents these correlations as within condition measures.

Table 1. *Descriptive statistics for all measures separated by condition; Determinism condition in bold font.*

Measures	Mean	(*SD*)

1. FWB	**76.07**	81.65	**(22.46)**	(19.61)
2. Self Efficacy	**4.23**	4.08	**(.56)**	(.67)
3. Control M+C	**4.05**	3.87	**(.61)**	(.86)
4. Control Author	**3.97**	4.12	**(.75)**	(.78)
5 Agreement	**37.34**	79.70	**(27.24)**	(17.37)
6 Education	**7.05**	7.17	**(1.65)**	(1.85)

Note. Control (M+C) = Control (Mastery and Constraints), Control (AA) = Control (Author of Actions).

Table 2. *Descriptive statistics and correlations among measures.*

Measures	Mean	(*SD*)	1.	2.	3.	4.	5.
1. Free will	79.16	(21.07)	--				
2. Self Efficacy	4.15	(.62)	.23**	(.92)			
3. Control M+C	3.95	(.76)	.37**	.71**	(.82)		
4. Control A A	4.05	(.77)	.71**	.42**	.54**	(.87)	
5 Agreement	60.81	(30.68)	-.09	-.10	-.15*	-.08	--
6 Education	7.12	(1.77)	.05	.08	-.07	-.02	.02

Note. Control (M+C) = Control (Mastery and Constraints), Control (AA) = Control (Author of Actions). When applicable, alpha reliabilities are presented in parentheses along the diagonal.

* $p < .05$, ** $p < .01$.

Table 3. Correlations for main measures for each condition separately; Determinism condition in bold font.

Measures	Free will		Self-Efficacy		Control (M+C)		Control (A A)		Agreement	
Free will	--	--								
Self-Efficacy	**.195**	.297**	**(.90)**	(.93)						
Control (M+C)	**.350****	.429**	**.717****	.702**	**(.74)**	(.86)				
Control (A A)	**.719****	.692**	**.362****	.485**	**.442****	.629**	**(.81)**	(.92)		
Agreement	**-.595****	.243**	**-.259***	.233*	**-.345****	.106	**-.506**	.155	--	**--**
Education	**.177**	.007	**.225***	.001	**.149**	-.185*	**-.506****	-.136	**-.220***	-.250**

Note. Control (M+C) = Control (Mastery and Constraints), Control (AA) = Control (Author of Actions).

When applicable, alpha reliabilities are presented in parentheses along the diagonal. * $p < .05$ ** $p < .01$.

Step 1

T tests

In step 1 of the analysis, a series of independent samples t-tests explored whether exposure to the deterministic video (compared to the non deterministic video)
would undermine participants' self-reported Self-efficacy (H1), Free will beliefs (H2), Control (Mastery and Constraints) (H3) and Control (Author of Actions) (H4).

In line with the prediction of (H2), on average, participants watching the deterministic video reported lower levels of Free will belief (M = 76.07, SE = 2.30), than participants who watched the non-deterministic consciousness video (M = 81.65, SE = 1.80), $t(211) = -1.93$, $p = .02$ (one tailed).

Contrary to the prediction of H4, the levels of Control (Author of Actions) reported by participants who watched the deterministic video (M = 3.97, SE = 0.07) were not significantly lower than participants who watched the non-deterministic consciousness video (M = 4.12, SE = 0.07) $t(211) = -1.41$, $p = .08$ (one tailed).

Contrary to the predictions of H1 and H3 participants who watched the deterministic video reported higher levels of Self-efficacy and Control (Mastery and Constraints). As we had directional hypotheses for these variables, this amounts to neither of these measures being significantly influenced by the video manipulator.

Exposure to a deterministic video lecture successfully undermined belief in free will compared to a non-deterministic video lecture. There were no significant between condition differences for the other three dependent measures.

Step 2

Parallel mediation analyses

For step 2 of our analysis we intended to conduct two parallel mediation models in order to test the predictions of H5 that, perceived Control (both measures) would better mediate the effect of condition on Self-efficacy than free will beliefs. However, our failure to find an effect of the video manipulation on self-efficacy in step one of our analysis prompted us to first explore the moderating role of participants agreement with the video lecture and their educational level before exploring the predictions of H5.

Step 3

Moderation analyses

We next tested the prediction of H6 (a) and (b), that the impact of condition on Free will, Self-efficacy, Control (Mastery and Constraints), Control (Author of Actions), would, be moderated by either (a) participants' Agreement with the video lecture or (b) their Educational level. Eight ordinary least squares multiple regression analyses were conducted via SPSS and the (Hayes 2017) process macro v3.3 for SPSS Model 1. Variables were mean centred prior to the construction of products. To assess the moderation of condition on each

of our 4 outcome measures by agreement and education, we tested the interaction between condition and each moderator on each of the 4 variable (see Tables 4 and 5). A significant interaction would provide evidence of moderation. Where the interaction terms were significant, the conditional effects of X on Y at the 16th 50th and 84th (Hayes 2017) percentiles of the moderators were calculated (also presented in Tables 4 and 5, where appropriate).

Table 4. *The effect of experimental condition on the 4 criterion variables moderated by participants' Agreement with the video lecture.*

Agreement

Variable	FW	SE	MC	AA
Interaction	*b*=-.03, *t*(209) = -6.26, *p* <.001	*b*=-.01, *t*(209) = -3.60, *p* <.001	*b*=-.01, *t*(209) = -2.66, *p* <.01	*b*=-.02, *t*(209) = -4.44, *p* <.001
High 30.95	*b*=-1.42, *t*(209) =- 7.43, *p* <.001	*b*=-.25, *t*(209) = -1.60, *p* =.11	*b*=-.31, *t*(209) = -1.64, *p* =.10	*b*=-1.00, *t*(209) = -5.38, *p* <.001
Average 9.19	*b*=-.76, *t*(209) = -5.27, *p* <.001	*b*=.06, *t*(209) = .53, *p* =.60	*b*= -.03, *t*(209) = -.21, *p* =.83	*b*=-.54, *t*(209) = -3.89, *p* =.001
Low -39.81	*b*=.74, *t*(209) = 2.85, *p* <.01	*b*=-.76, *t*(209) = -3.61, *p* <.001	*b*=.61, *t*(209) = 2.34, *p* =.02	*b*=.49, *t*(209) = 1.94, *p* =.053

Note. Variables were mean centred prior to the construction of products. High, Average and Low represent the 16th 50th and 84th percentiles of the mediator, message Agreement. Significant results are displayed in green with results that failed to reach significant in red.

Table 5. *The effect of experimental condition on the 4 criterion variables moderated by participants' Educational level.*

Education

	FW	SE	MC	AA
Interaction	*b*= .07, *t*(209) = .99, *p* =.32	b=.08, *t*(209) = 1.54, *p* =.12	*b*=-.14, *t*(209) = 2.35, *p* =.02	*b*= .12, *t*(209) = 1.98, *p* =.05
High 1.8826			*b* = .43, *t*(209) = 2.83, *p* =.005	*b*=.08, *t*(209) = .50, *p* =.61
Average .88			*b* = .29, *t*(209) = 2.53, *p* =.01	*b*=-.04, *t*(209) = -.35, *p* =.73
Low -2.1174			*b*= -.13, *t*(209) = -.78, *p* =.44	*b* = -.40, *t*(209) = -2.43, *p* =.01.

Note. Variables were mean centred prior to the construction of products. High, Average and Low represent the 16th 50th and 84th percentiles of the moderator, level of Education. Significant results are displayed in green with results that failed to reach significant in red.

Figure 1. *Free will, Self-Efficacy, Control (Mastery and Constraints), Control (Author of Actions) moderated by participants' level of Agreement with the video lecture. Green arrows represent the between condition comparisons that reached statistical significance. At low agreement the effect of condition on Control (Author of Actions is significant at p= .053 or bellow w=40.43 (see green dotted line).*

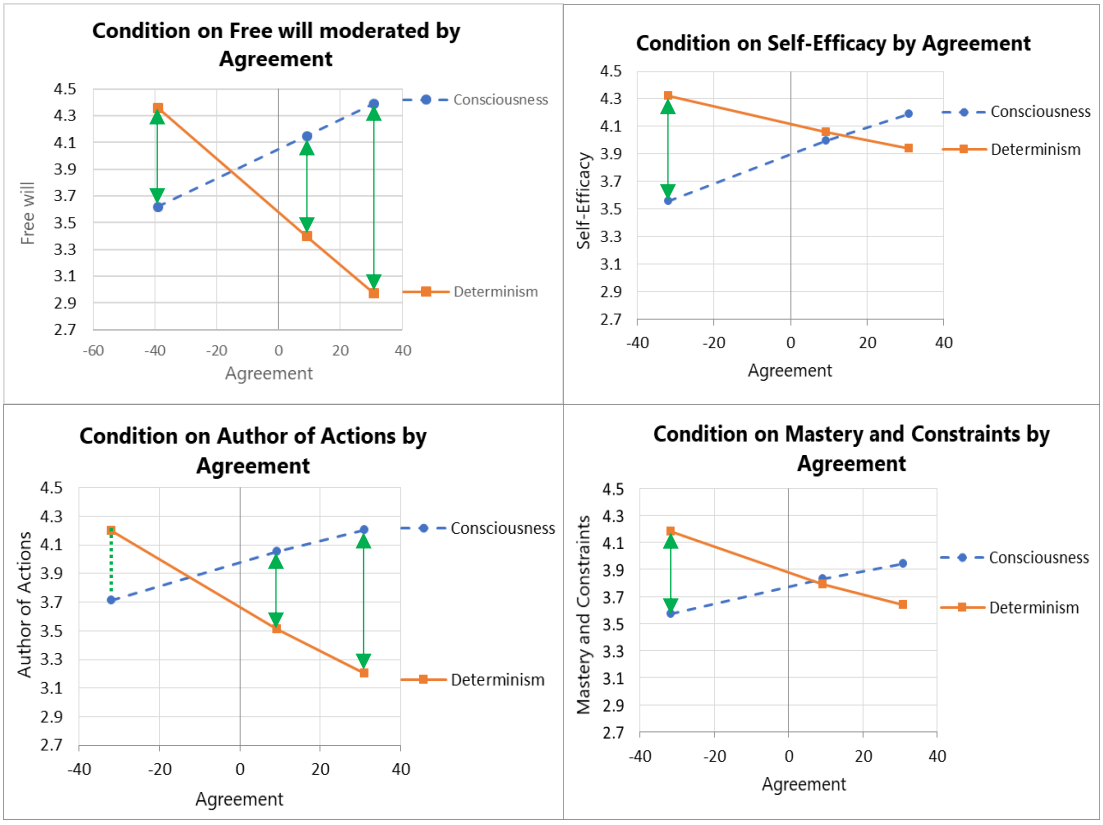


Figure 2. *Control (Mastery and Constraints), Control (Author of Actions) moderated by participants' Educational level. Green arrows represent the between condition comparisons that reached statistical significance.*

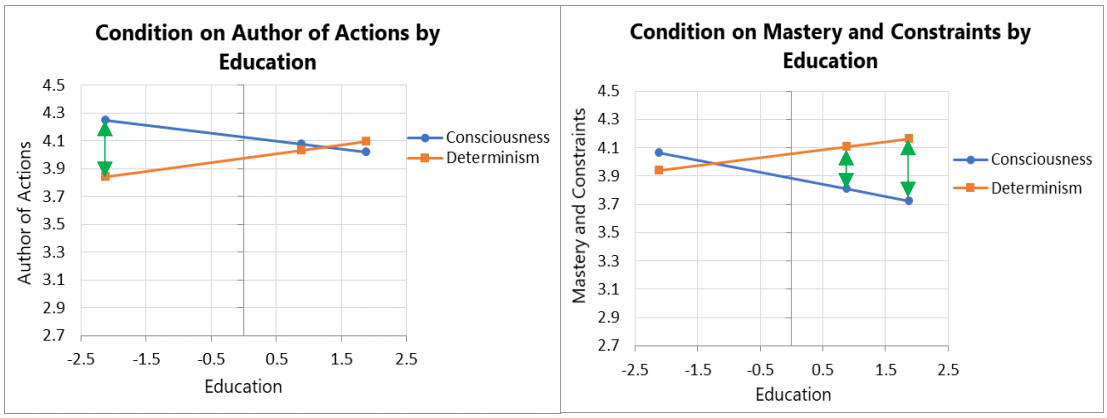


Table 4 and Figure 1 and demonstrate that the moderating effect of participant agreement was significant for all criterion variables. In the subsequent sections each of these results will be briefly described.

Impact of condition at high message agreement on free will and control Author of Actions. The predictions of H6a only focus only on the impact of the manipulation at high levels of Agreement with the video lecture. Table 4 and figure 1 demonstrate that H6 a) was supported for the variables Free will belief and Control (Author of Actions). Significant interactions were observed meaning that the relationship between experimental condition and these 2 outcome variables was significantly moderated by participants' Agreement with their lecture. More specifically, this means that, compared to participants exposed to the non-deterministic lecture, exposure to the deterministic lecture, predicted significantly lower belief in Free will and

Control (Author of Actions), but only for those who agreed with their video lecture. This was true at both average W=9.19 (mean centred) and relatively high W=30.95 (mean centred) levels of message Agreement. Put another way, exposure to the deterministic video (compared to the non-deterministic video), predicted reduced Free will belief and perceived Control (Author of Actions) for those at average and relatively high Message Agreement.

Impact of condition on free will and Control (Author of Actions) at low message agreement. Other relationships were tested in addition to the assumptions of H6 a). these relationships concerned the impact of condition on the outcome variables at low message agreement. At relatively low levels of agreement W=-39.81 (mean centred) exposure to the deterministic video lecture (compared to the non-deterministic video on consciousness), was associated with significantly higher belief in Free will. In other words, those who disagreed with determinism reported greater belief in Free will than those who disagreed with non-determinism.

The impact of condition on Control (Author of Actions) did not reach the threshold for statistical significance at low message agreement but came close at (p = .053). We therefore conducted a floodlight analysis. The Johnson–Neyman statistics revealed that for the 14.5 percent of data points equal to or lower than W=-40.34 (mean centred) exposure to the deterministic lecture (compared to the non-deterministic lecture on consciousness) predicted significantly higher levels of perceived Control (Author of Actions).

Put another way, low Agreement, for those exposed to the deterministic video, predicted higher Free will belief and Control Author of Actions (relative to the non-deterministic condition).

Overall then, it seems that for both Free will beliefs and Control (Author of Actions) the mediating effect of message Agreement acts in a similar fashion. Agreement with the video for those in the deterministic condition, predicted lower levels of Free will belief and perceived Control Author of Actions (compared to agreement in the non-deterministic condition). Disagreement with the video for those in the deterministic condition, predicted higher levels of Free will belief and perceived Control Author of Actions (compared to disagreement with the video in the non-deterministic condition).

The variables Free will belief and Control (Author of Actions) display notable similarities when visually inspecting their interaction charts and in terms of their identical significant relationships at both ends of the moderator. This suggests that they may be drawing upon similar concepts.

Impact of condition at high message Agreement on Self efficacy and Control Mastery and Constraints. Table 4 and figure 1 demonstrate that H6 a) was not supported in regard to the variables Self-efficacy and Control (Mastery and Constraints). Although significant interactions were observed for both variables the effects of condition on these variables was not significant at high levels of participant Agreement (a requirement of H6 a).

Impact of condition on Self efficacy and Control Mastery and Constraints at low message agreement. Other relationships were tested in addition to the assumptions of H6 a). At relatively low levels of message Agreement, exposure to the deterministic video lecture predicted significantly higher Self Efficacy and Control (Mastery and Constraints) compared to exposure to the non-deterministic video lecture. This finding mirrors the results for Free will and Control (Author of Actions). Therefore, disagreement for participants in the deterministic condition, predicted increases in Free will belief, Self-efficacy, and both measures of control (compared to disagreement for participants in the non-deterministic condition). Disagreement with determinism appears to be associated with higher scores in all four criterion variables whereas disagreement with non determinism appears to be associated with lower scores.

The moderating role of Educational level. Table 5 and figure 2 demonstrate that the moderating impact of Educational level was significant only for the two measures of Control. *The predictions of H6 b did not specify the direction of responses at low or high levels of the moderator.* Table 5 and figure 2 demonstrate that H6 b) was supported in regard to the variables Control (Author of Actions) and Control (Mastery and Constraints) with significant interactions observed. For participants with an average .88 (mean centred) and relatively high 1.88 (mean centred) level of Education, watching the deterministic video lecture resulted in higher levels of Control (Mastery

and Constraints) compared to those participants who watched the non-deterministic lecture on consciousness. Finding higher ratings of Control (Author of Actions) for those with a relatively high education could be an indication of participant reactance. Reactance (Brehm 1966; Miron & Brehm, 2006) is a person's drive to resist perceived threats to their sense of being a free agent, able to behave as they choose. Reactant participants have been known to not only resist the intended manipulation but to even respond in a manner, opposite to the intended demands of the manipulation. For example, compared to those reading the neutral text, participants high in trait reactance reported lower belief in determinism after reading the pro determinism/anti free will text (Ent, 2013).

Our finding, that those with a relatively high education reported higher ratings of Control (Author of Actions) in the deterministic condition (compared to those with a relatively high education in the none deterministic condition) suggests reactance. Better educated participants seem to have responded to the challenge to their perceived freedom to choose by claiming even greater ability to freely choose. We will re visit this topic in the discussion section.

For participants with a relatively low level of education -2.12 (mean centred), watching the deterministic video lecture resulted in significantly reduced Control (Author of Actions) compared to those who watched the non-deterministic lecture on consciousness.

H6 b) was not supported in regard to the variables Free will belief and Self-Efficacy as no significant interactions were observed.

Step 4

Cheating behaviour

Step 4 of our analysis tested hypothesis 7. Logistic regression was used to test for any between condition differences in cheating behaviour. We then planned to confirm the expected null result with Bayesian equivalence testing.

Binary logistic regression tested the prediction of H7 that there would be no impact of condition on cheating behaviour. The Model was significant ($X^2$1, N = 212) =5.125 p=.02. The Nagelkerke pseudo R^2 indicated that the model accounted for 4% of the total variance. Contrary to the prediction of H7, participants exposed to a non-deterministic video lecture on consciousness cheated more than participants exposed to a video lecture championing determinism. Table 6 presents the Partial regression coefficients, Wald test, odds ratio [Exp(B)] and 95 % confidence intervals for the odds ratio for experimental condition.

Table 6. *Binary logistic regression results.*

Measures	*b*	SE-b	Wald	df	Exp (B)	95% CI Exp (B)
Condition	-.824	.376	4.806	1	.439	.210- 210
Constant	-.1.110	.214	26.877	1	.330	

Note. The dependent variable was labelled Cheated, with cheated (1) as the target category and not cheated (0) as the reference category. The predictor, condition was coded with determinism (1) and non deterministic consciousness (0) as the reference.

A parallel mediation path analysis was conducted, via the Hayes (2017) process macro v3.3 for SPSS model 4, to test the predictions of H8 that, perceived Control (both measures) better mediates the effect of condition on cheating behaviour than Free will beliefs. Contrary to the predictions of H8 when compared in a parallel mediation model neither Free will beliefs (*b*=-.07) [CI] -.2590 to .0398 or perceived Control (Mastery and Constraints) (*b*=-.05) [CI] -.2008 to .0354 mediated the impact of condition on cheating. The same true when Free will beliefs (*b*=-.11) [CI] -.3788 to .0246 and Control (Author of actions) (*b*=-.06)[CI] -.0450 to .2870 mediated the impact of condition on cheating.

Exploratory conditional process analysis

In step 1, exposure to the deterministic video significantly reduced free will belief but failed to significantly reduce the other three dependent measures. In step 3 participant Agreement successfully moderated the impact of condition on all 4 criterion variables. The impact of condition on the 4 criterion variables was better observed when moderated by message Agreement. We therefore decided to run our two parallel mediation analyses (from step 2) but with the addition of participant Agreement moderating the impact of the manipulation on Self-efficacy (direct pathway) and the two mediators (indirect pathways).

Two separate ordinary least squares path analysis with their products mean centred were conducted via the (Hayes 2017) process macro v3.3 for SPSS Model 8 and following the procedure from Hayes 2017 for conditional process analysis (see figure 3 model 1 and figure 4 model 2). Model 1 assessed the impact of the manipulation on Self-efficacy directly and compared the relative utility of the 2 mediators, Free will belief and Control (Author of Actions) to mediate the impact of Condition on Self-efficacy. Model 2 was identical but with Control (Mastery and Constraints) replacing control (Author of Actions) as the second mediator. In both models participant Agreement with the video lecture moderated the impact of the manipulation on Self-efficacy (direct pathway) and the two mediators (indirect pathways).

Figure 3. *Model 1, a conditional process model testing the relative utility of Free will belief and Control (Author of Actions) to mediate the impact of Condition on Self-efficacy. Paths a_1, c', and a_2 were moderated by message Agreement. Significant coefficients are coloured green, non-significant are in red.*

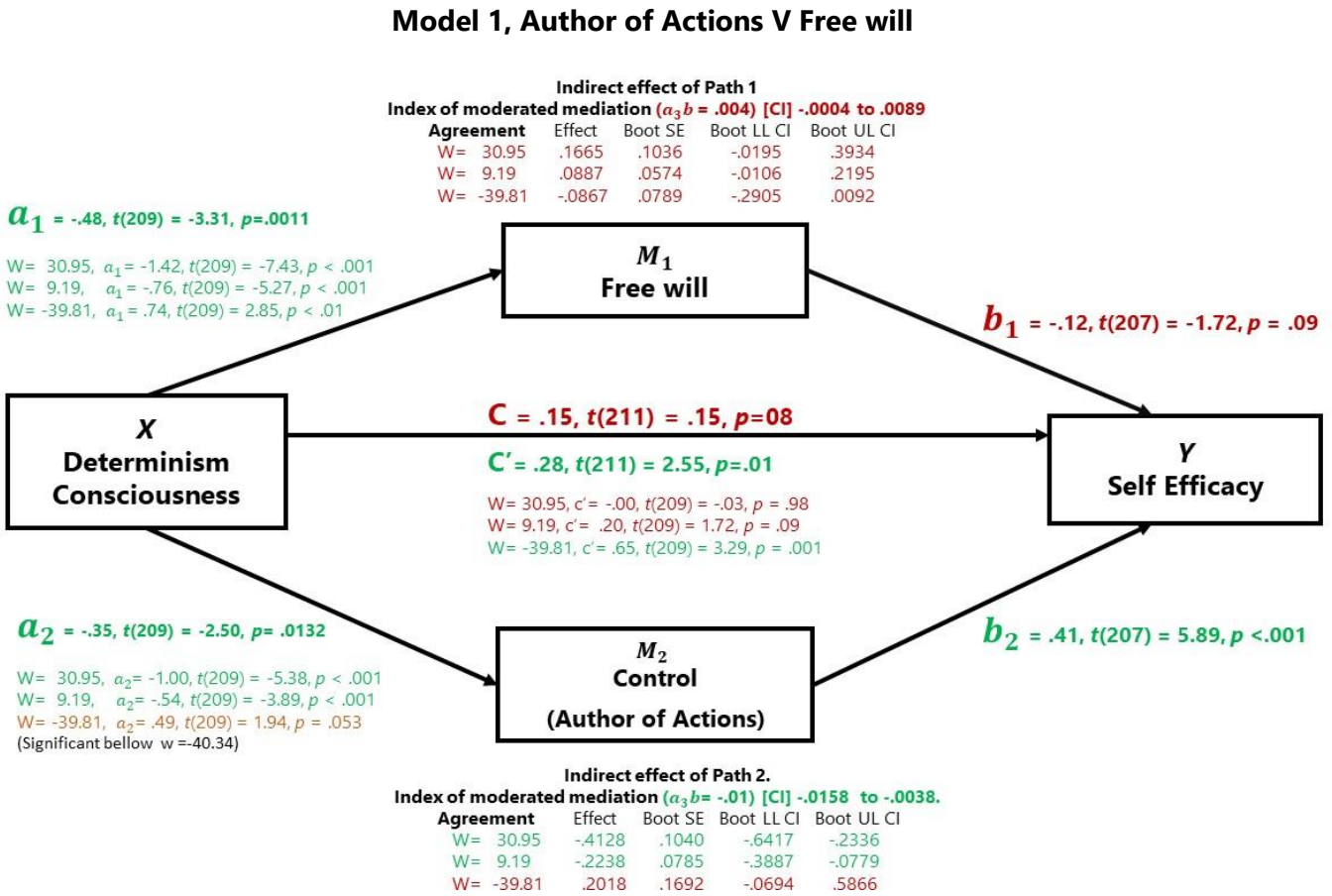
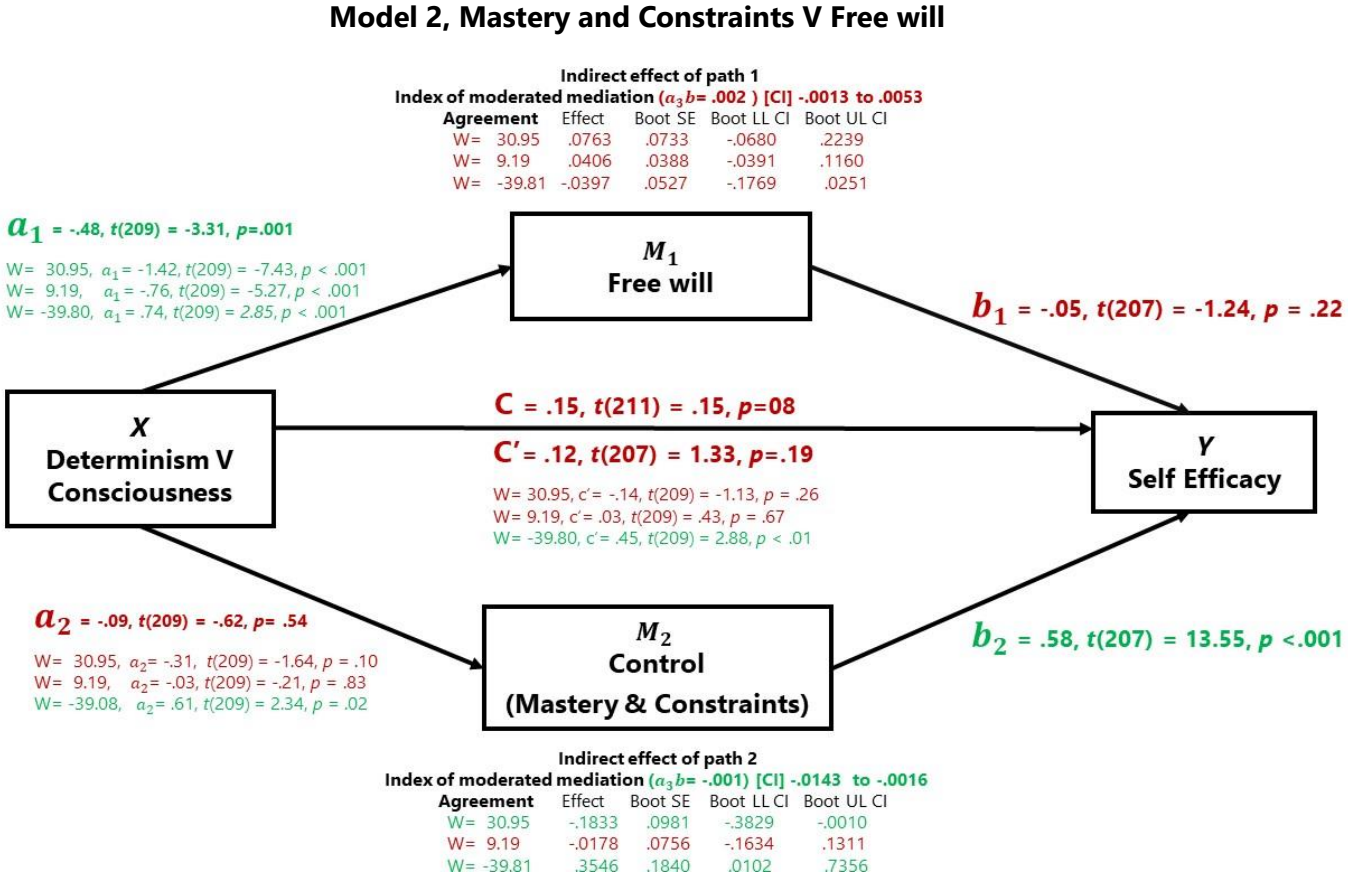


Figure 4. *Model 2, a Conditional process model testing the relative utility of Free will belief and Control (Mastery and Constraints) to mediate the impact of Condition on Self-efficacy. Paths a_1, c', and a_2 were moderated by message Agreement. Significant coefficients are coloured green, non-significant are in red.*



We first tested the ability of Free will beliefs and our two measures of Control to mediate the impact of condition on Self-efficacy. Model 1 (figure 3) and model 2 (figure 4) demonstrate that, once moderated by message Agreement, both measures of Control better mediated the impact of experimental condition on Self-efficacy than Free will beliefs. The index of moderated mediation was significant for the conditional indirect effect mediated by Control (Author of Actions) (a_3b= -.01) [CI] -.0158 to -.0038 (Model 1) and the conditional indirect effect mediated by Control (Mastery and Constraints) (a_3b= -.001) [CI] -.0143 to -.0016 (model 2). By contrast both pathways mediated by Free will belief did not reach significance (a_3b= .004) [CI] -.0004 to .0089 (model 1) and (a_3b= .002) [CI] -.0013 to .0053 (model 2). Overall then, when moderated by participant Agreement, the two measures of Control mediated the impact of Condition on Self efficacy to an extent that was significantly significant. There was no significant role for free will beliefs.

We also explored the direct effect of condition on self-efficacy. In model 1 the direct effect of experimental Condition on Self-efficacy controlling for the two mediators, Free will beliefs and Control (Author of Actions), was significant (C'= .28, t(211) = 2.55, p=.01) at the mean level of the moderator (message Agreement). This counterintuitive positive effect indicates that participants exposed to the deterministic video lecture reported higher levels of Self-efficacy than participants exposed to the non-

deterministic video lecture. This result might reflect the fact that participants are acting in a reactant manner by reporting increased self-efficacy after an attempt to undermine their perception of being able to freely exercise choice and exert control. We will return to this possibility in the discussion.

We next looked at the differences between our two measures of control. As outlined above, once moderated by participant agreement, both measures of control significantly mediated the impact of condition on Self efficacy in their respective models. But the two measures of Control did so in different ways.

In model 1, with Control (Author of Actions) acting as M2 the overall conditional indirect effect of condition on Self-efficacy was significant and negative at both average b= -.22, SE=.08, [CI]-.3887 to -.0779, and relatively high b=-.41, SE=.10, boot [CI] -.6417 to -.2336, levels of the moderator (message Agreement).

This means that when focusing on those participants that agreed with the content of the videos, those in the deterministic condition showed reduced Self-efficacy compared to those in the non-deterministic condition. This relationship happened via people's perceived Control (Author of Actions), with high agreement with determinism predicting reduced Control a_2 = -1.00, $t(209) = -5.38$, $p < .001$ and Control predicting reduced Self efficacy b_2 = .41, $t(207) = 5.89$, $p < .001$. In model 1 then, Agreement with determinism appears to predict reduced perceived Self-efficacy by impacting people's perceptions

of having Control. Perceptions of having Control then impact perceived Self-efficacy.

Turning our attention now to model 2, we see that the manipulation impacts self-efficacy differently. In model 2, with Control (Mastery and Constraints) acting as M2 the overall conditional indirect effect of Condition on Self-efficacy was significant and negative at relatively high levels of Agreement b= -.18, boot SE= .10 [CI] -.3829 to -.0010 but also significant and positive at relatively low levels of Agreement b=.35, boot SE= .18, [CI]= .0102 to .7356. Put another way, people in the deterministic condition who agreed with the video lecture, reported lower levels of Self-efficacy, than those in the non-deterministic condition who agreed with the video lecture. When participants disagreed with the video lecture the opposite was true with those exposed to the deterministic lecture reporting increased Self-efficacy. These relationships happen via people's perceived control (Mastery and Constraints). Low agreement with determinism (compared to low agreement with non-determinism) predicted increased Control a_2= .61, $t(209) = 2.34$, $p = .02$ and perceived Control predicted reduced Self efficacy b_2 = .58, $t(207) = 13.55$, $p < .001$.

The inclusion of the indirect pathways results in a conditional direct effect that is significant and positive at relatively low levels of the moderator, message Agreement, for both model 1 c'= .65, $t(209) = 3.29$, $p = .001$ and model 2 c'= .45, $t(209) = 2.88$, $p < .01$.

Put another way, across both conditional process models, people in the deterministic condition who disagreed with the content, reported higher levels of Self-efficacy, than those in the non-deterministic condition that also disagreed with the content. These findings of low agreement with determinism predicting increased Self efficacy, (relative to the non deterministic condition) may be the result of participants lay incompatibilism, with those who disagree with determinism likely to be free will believers. Free will believers will likely also score highly on the correlates of free will, including self-efficacy. We will return to this subject later.

Discussion

In the current study we aimed to construct an enhanced manipulation of belief in determinism that addresses some of the theoretical and practical limitations of the stimuli typically used, and to explore how this new manipulator affects individuals' belief in free will, sense of personal control, and self-efficacy. We developed a new video with either a deterministic or non-deterministic voice over. We found that this video impacted individuals' belief in free will but had no significant effect on their sense of control or self-efficacy. Nonetheless, when including message agreement as a moderator, we found a pattern of results which suggested that all three of these outcome

variables were influenced by the manipulator, dependent on level of agreement.

Creating and testing a new manipulation. We constructed and tested an enhanced manipulation of deterministic beliefs. The deterministic lecture was designed to contain only elements pertinent to modern popular accounts of determinism while removing many of the potentially confounding influences inherent in the Crick essays and Velten (1968) manipulators currently used. The non-deterministic lecture on consciousness was designed to represent a neutral condition. However, the moderation analysis points to the possibility that it functioned more as a non-deterministic condition, that is to say, something closer to a pro free will condition, rather than a true neutral condition. The fact that we strove to make this condition non-deterministic, combined with participants tendencies to believe in free will (Sarkissian et al., 2010), might have resulted in this condition reducing deterministic beliefs in our study. For this reason, we refer to it as the non-deterministic condition rather than the neural condition.

What is the nature of our two measures of control? Across the various analyses conducted in this study, we observed marked similarities between our measures of free will belief and our measure of control (Author of Actions) and between our measures of Control (Mastery and Constraints) and Self-efficacy. This is highlighted by the strong correlations between these pairs of measures and further reinforced by the moderation analysis. A visual

inspection of the interaction charts (Figure 1) demonstrates this point. When moderated by message Agreement, the effect of condition on Free will beliefs was significant at all three levels of the moderator with 2 out of the three comparisons situated above the zero point of the mean centred interaction. These Characteristics were mirrored by Control (Author of Actions) admittedly with the comparison at low agreement significant only at (p = .053) or below w= 40.34. By contrast the effect of Condition on Self-efficacy was significant only at low agreement, with the 2 nonsignificant comparisons occurring above the zero point of the mean centred interaction. The impact of Condition on Control (Mastery and Constraints) mirrors these characteristics. This combined with the high pattern of correlations between these measures (see table 2) suggests that our measures of Free will beliefs and Control (Author of Actions) overlap conceptually as do the measures of Self-efficacy and Control (Mastery and Constraints). It has been well established that lay concepts of free will centre around the ability to make choices free from constraints (Monroe & Malle, 2010; 2014 studies 1 and 2) this finding suggests that lay free will intuitions draw more on notions of choice related to being in control of ones actions and decisions than to notions of choice related to having mastery and being free from constraints.

Low agreement with determinism and lay incompatibility.

A clear pattern was observed when the impact of condition on the 4 outcome variables was moderated by message agreement (steps 3 and 4). We argue that these findings are best interpreted through the lens of lay incompatibilism.

We find across all 4 moderation analyses (step 3) that at low message agreement participants in the determinism condition score significantly higher on all 4 outcome variables than participants in the non-deterministic condition. Although the impact of Control (Author of Actions) achieved p=.053 and was significant =< W=-40.34).

Similarly, at low message Agreement the conditional direct effect for both models 1 and 2 are positive and significant, even after controlling for Free will beliefs and both measures of Control. Participants in the Deterministic condition who disagreed with the content of their video lecture reported higher levels of Self-efficacy than participants in the Non-deterministic condition who disagreed with their lecture. The conditional indirect effect of Condition on Self-efficacy via Control (Mastery and Constraints) was also significant and positive at low message Agreement for model 2.

Taken together these findings demonstrate a clear pattern, with those who disagree, in the Deterministic condition, reporting higher levels of Free will, Control (both measures) and Self efficacy (than those who disagree, in the Non-deterministic condition).

One likely explanation for this is rooted in lay incompatibility. Those who disagree with determinism are likely to be free will believers, and therefore likely to score higher on measures of free will and its correlates (control and self-efficacy) than people who disagree with non-determinism. Those individuals, who reject the non-deterministic account, are likely staunch determinists who are inclined to believe less in free will and its correlates (control and self-efficacy).

Put more simply, people who disagree with determinism believe more in their capacity for free will, control and self-efficacy than individuals who disagree with non-determinism. People who disagree with non-determinism embrace determinism and are less inclined to believe that they have free will and control. This impacts their sense of self efficacy.

This explanation assumes that participants who are very strong believers in either stance, are less likely to be affected by the video messages.

An alternative explanation would be that part of this effect may be due to the impact of participant reactance prompting some participants in the deterministic condition to claim greater free will, control and self-efficacy as a response to our attempt to undermine them. Indeed, findings consistent with reactance were observed for the conditional process (model 1) where control Author of Actions served as the second mediator (M_2). Here we observed a significant positive direct effect of condition on self-efficacy. Participants in

the deterministic condition reported significantly higher belief in self efficacy than those exposed to the non-deterministic account.

We will return to this issue in the general discussion and explore ways in which future research may help to further elucidate the role of reactance in free will belief manipulations.

High agreement with determinism. At low levels of message Agreement, it is impossible to discern the extent to which prior beliefs/lay incompatibilism, in tandem with trait reactance, drives the increase in the 4 criterion variables and to what extent any manipulation effect is opposing that increase. However, the impact of condition on our 4 criterion variables can also be explored at high levels of participant Agreement.

When focusing only on those participants that agreed with the content of the videos, those in the Deterministic condition reported reduced beliefs in Free will and Control (Author of Actions) compared to those in the Non-deterministic condition.

At average and relatively high levels of message Agreement the conditional indirect effect of condition on Self efficacy via Control (Author of Actions) was negative and significant for model 1. This means that (relative to participants in the Non deterministic condition who also agreed) Agreement with the video lecture in the deterministic condition predicts reduced perceived Control (Mastery and Constraints), this in turn impacts perceived Self-efficacy.

As far as we are aware, finding that agreement with a deterministic message predicts reduced perceived Self-efficacy via perceived Control, represents a new contribution to the literature.

An alternative explanation, might attempt to attribute these results to the overlap between the wording of the deterministic video lecture and the wording of the question items in Control Author of Actions. The demand characteristics inherent in this overlap might lead those participants who were keen to please the researchers to both agree with the videos and report reduced perceived Control (Author of Actions). This explanation seems less likely due to the broad, multifaceted nature of the video lectures and the decision to position the measures most susceptible to demand characteristics last in the order of presentation. Additionally, the between condition effect observable at high agreement, is also contributed to by the moderating effect of message agreement on those in the non-deterministic condition. As can be seen in in Figure 1, the moderating effect of message agreement on Control (Author of Action) constitutes both a decrease in Control as agreement increased in the deterministic condition, but also an increase in Control as message agreement increased in the non-deterministic condition. While the first part of this effect might be due to demand characteristics, this seems extremely unlikely for the second part (the increase with agreement in the non-deterministic condition) since overlapping language between the

wording of Author of Actions and the wording of the non-deterministic video is almost zero.

Demand characteristics cannot be completely discounted however and future research should endeavour to reduce demand characteristics even further, perhaps by exploiting one of the more implicit measures of control that have been used successfully after an anti-free will manipulation (Rigoni et al., 2011; Lynn et al., 2014).

Society may well be marching towards an increasingly deterministic worldview with more and more causally based theories employed to explain human thoughts, feelings, behaviours and the complex systems that humans navigate to achieve our life goals. Any potential impact of deterministic belief on perceived Self-efficacy (via perceived Control) could have important real-world implications.

This research suggests that beliefs that attribute all human thoughts and behaviour to prior events and brain states while describing all future outcomes as fixed, may impact perceived self-efficacy more than accounts that leave open the possibility that human conscious experience and future outcomes are unknown.

Determinism, Free will and Incompatibilism. In step 1 we tested to see if our new hard hitting pro deterministic manipulation would impact Free will beliefs at the level of the mean. In doing so we tested whether participants see determinism (as conceptualised for our study) as

incompatible with their lay understandings of what it means to have free will. Exposure to a deterministic video lecture (compared to a non-deterministic video lecture on consciousness) successfully reduced belief in Free will. This is despite neither lecture containing any reference to free will, instead modulating concepts relevant to choice, control, neuro reductionism and uncertainty. Participants viewed this hard-hitting form of determinism as incompatible with belief in free will. To the best of our knowledge finding that a purely deterministic argument, that contains no mention of free will, can undermine belief in free will represents a new contribution to the literature.

The role of Free will beliefs and perceived Control. We wanted to demonstrate that perceived Control (both measures) would better mediate the effect of Condition on Self-efficacy than Free will beliefs. To achieve this moderation was required. Once message Agreement assumed the role of moderator, the two measures of Control provided conditional indirect effects that were significant in both models. Free will beliefs failed to provide conditional indirect effects that were significant in either model. Therefore, in both models 1 and 2 perceived Control better mediated the impact of condition than Free will beliefs (once message Agreement was introduced as moderator). In studies 2 and 3 (chapter 4) measures of control better predicted subjective wellbeing than free will beliefs. Here, once Control (both measures) were entered into the models, there was no role for Free will beliefs

in predicting Self-efficacy. This is despite the effect of condition significantly impacting Free will beliefs when compared at the level of the mean in step 1.

Only the indirect pathway (model 1) mediated by Control (Author of Actions) was significant at high agreement in terms of both the a_2 path and the overall indirect effect. As we have argued in a previous paragraph, this measure seems to draw on notions of control over one's decisions and choices. We felt that this conceptualisation is similar to the lay understanding of free will (Monroe & Malle, 2010). Agreement with determinism does not impact Self efficacy via Free will beliefs it does impact Self-efficacy via notions of being in control of one's decisions and choices. This suggests that future research seeking to explore the relationship between belief and Self-efficacy should manipulate perceived control by modulating belief in hard determinism rather than attempting to undermine free will belief.

Our finding suggests that the previously documented relationship between free will beliefs and self-efficacy (Crescioni et al., 2016) may, like the relationship between free will belief and subjective wellbeing, be epiphenomenal, drawing on the covariation of free will beliefs and perceived control (see studies 2 and 3 in chapter 4). An important distinction must be drawn however between the two pieces of research. In the present study we compared Agreement with determinism and how it impacts Self efficacy via control whereas in studies 2 and 3 we used multiple regression to compare the predictive utilities of free will beliefs and perceived control in predicting

subjective wellbeing, regardless of participant agreement with determinism or non-determinism.

The impact of determinism on cheating. Contrary to the predictions of H7 and H8 exposure to a non-deterministic lecture on consciousness produced significantly more cheating than exposure to a deterministic lecture. This finding runs contrary to the early literature. In that when findings have been significant exposure to determinism typically leads to increases in forms of antisocial behaviour (Vohs & Schooler, 2008; Baumeister, 2009). Finding the opposite runs counter to the literature but is broadly in line with a finding that saw exposure to a message supporting neural determinism, result in less vindictive behaviour, (female participants only) (Caspar, Vuillaume, Magalhães De Saldanha da Gama & Cleeremans, 2017) and belief in free will predict acceptance of economic inequality (Mercier, Wiwad, Piff, Aknin, Robinson, & Shariff, n.d). Other researchers have found no substantial evidence linking free will beliefs to moral behaviour (Crone & Levy, 2018).

Limitations and suggestions for future research. Efforts were made to reduce demand characteristics by presenting a deterministic account that does not mention free will and minimised, where possible, the language overlap between the manipulation and the dependent measures. In a previous section we acknowledged that our efforts to remove all demand characteristics might not have been completely successful but also why we do not believe that they drove the observed effects. Further steps should also be

taken to reduce potential demand characteristics in any follow up study. To help reduce demand characteristics, future studies should follow the advice of Schooler (2014) and split the manipulation and dependent measures into two separate parts that the participants believe to be unrelated. We doubt that experienced MTurk workers would fall for such a strategy when employed online. These framing effects did not lead to a successful replication of Vohs and Schooler (2008) when employed online by Nadelhoffer et al. (2019). These framing effects are likely best employed in a lab setting where participants can be moved between rooms and researchers (counterbalanced) to fully sell the illusion of two separate unrelated studies. Any follow up to this current study will follow this approach and perhaps also employ a measure of participant suspicion to further probe demand characteristics.

Message agreement when used as a moderator allows us to differentiate between those who disagree with determinism and are potentially reactant, from those who agree and are unlikely to be reactant. However, although reactant participants are likely to express their disagreement, disagreement does not guarantee reactance. The effect of reactance would need to be accounted for in order to quantify the true effect of lay incompatibilism. This was not achieved in our study. Similarly at high agreement we cannot discern what portion of the observed effect is due to participants simply agreeing with the deterministic/nondeterministic videos

because they already held those views, and what portion is due to a manipulation effect bringing their views into alignment with the video lecture.

Future research should strive to further disentangle these relationships, perhaps by also including the measure of trait reactance employed successfully by (Ent, 2013) and by measuring participants pre manipulation beliefs.

A measure that taps into participants' belief in determinism could also be employed although such a measure would likely induce substantial demand characteristics and would best be presented after key dependent measures. We created a broad ranging deterministic manipulation for this study. The measurement of post manipulation belief in determinism may best be handled by a range of individual slider measures that tap the individual constituents of our broad ranging manipulation. This would allow us to see what aspects of the manipulation were effective and what aspects of the manipulation predicted dependent measures, such as perceptions of self-efficacy and behaviour.

Our non-deterministic condition ended up functioning as something closer to a pro free will condition, rather than a true neutral condition. Future studies should include a third, true neutral condition that avoids any stance (even a neutral one) on any topic relevant to determinism.

Conclusion

The current research project succeeded in its aim to construct an enhanced manipulation of belief in determinism that addresses many of the theoretical and practical limitations of the currently used stimuli. This manipulation successfully undermined perceptions of Free will but not Control or Self-efficacy. Cheating was modulated although not in the predicted direction. The impact of potential reactance was discussed and its differing impacts on measures of Free will, Control and Self-efficacy explored. Suggestions to control for/disentangle reactance effects in future research were proposed. Overall, the current study demonstrated that belief in determinism can predict self-efficacy and that this relationship acts directly and via perceived control but not via free will beliefs.

Chapter 8

General discussion

In chapter one we provided an overview of the literature and introduced some of the methods used to investigate free will beliefs and their impact on behaviour, cognitions and life outcomes.

In chapter two we outlined some of the limitations in the current literature and proposed strategies for improvement. They are as follows. Many researchers have assumed that lay participants see free will and determinism as incompatible. This has led to anti free will manipulations that contain both anti free will and pro deterministic statements in the same condition, and to the inappropriate combination of subscales that measure free will and determinism, despite those subscales documented independence. These free will measures were already broad, with free will subscales that include questions relating to choice, control over life outcomes, moral responsibility and direct references to free will. (see Rakos et al., 2008; Carey & Paulhus, 2013). Including anti free will statements in a manipulation and measuring their impact with free will subscales that include questions that directly ask about free will, can only heighten demand characteristics.

When broad ranging manipulations are used and their impact is measured using broad ranging free will subscales, it's hard to know what

aspect of the broad manipulations actually impacted cognitions and behaviours. This, combined with contested free will definitions required the introduction of single item measures that target only the individual's lay concepts of determinism and free will (see Feldman, 2016; McKenzie, 2014 for examples of single item measures of free will). These single item measures of free will and determinism should be used to gauge the impact of new better focused manipulations that target only belief in free will and determinism. In terms of these multi item free will measures we suspect that it is the questions tapping perceptions of choice and control that are responsible for these measures ability to predict indicators of subjective wellbeing. We were also keen to create a new simpler online measure of cheating.

To address these issues, we aimed to achieve the following: (1) Confirm past research showing that lay free will concepts centre around participants' perceptions of having the capacity for unconstrained choice. (2) Create and begin validation of new single item measures of free will and determinism. (3) Check to see if participant's see the concepts tapped by these new measures of free will and determinism as compatible or incompatible. (4) Create and test a new quick and simple measure of cheating that can be used online. (5) Test our suspicion that it is concepts relating to choice and control that underpin the ability of free will beliefs to predict subjective wellbeing. (6) Beguin exploring whether the manipulation of perceived choice and control is a better way of exploring the impact of belief on life outcomes. (7) If

necessary, create a better focused manipulation of free will beliefs that minimises demand characteristics and test its effectiveness in impacting perceptions relating life outcomes. To address these questions we conducted the following research.

Overview of research

The above aims were addressed over the course of the 7 studies conducted for this research project. In chapter 3, study 1 confirmed past research by demonstrating that perceptions of possessing choice in the face of external constraints (with an element of forethought) form the core of lay persons free will beliefs (Monroe & Malle 2010; 2014). We began the validation of our new single item slider measures of free will and scientific determinism. We tested the assumption of lay incompatibility for those slider measures and added to the studies challenging the assumption of lay incompatibility regarding the free will and scientific determinism subscales of the fad plus (Paulus & Carey, 2011). These results and past findings (Paulhus & Carey 2011; Feldman et al., 2014) suggested that better focused manipulations of free will and determinism should be developed that do not include anti free will and pro deterministic elements in the same experimental condition. Also in study 1 our new measure tested for cheating by providing participants with an opportunity to skip a task by making a dishonest claim. This measure demonstrated a good baseline level of cheating and was taken forward to the final study.

We reasoned that as free will beliefs predict indicators of subjective wellbeing (Crescioni et al., 2015; Li et al., 2017) and lay concepts of free will, centres around perceived choice (Monroe & Malle 2010; 2014 and study 1), it could be this overlap, between perceptions of choice and control (inherent to lay free will understandings), that underpins the relationship between free will beliefs and indicators of subjective wellbeing. In chapter 4, Studies 2 and 3 demonstrated that this was indeed the case. We also reasoned that as the text based manipulations have been shown to (sometimes) impact free will beliefs and behaviour, this relationship could also be drawing on perceptions of choice and control. That is to say that text based manipulations such as the Crick essay, may also impact perceptions of choice and control undermining them, and in turn impact cognitions and socially relevant behaviour.

To test this, we first wanted to see if the Crick essay could impact perceived control. In chapter 5 study 4 the full version of the Crick essay failed to impact control beliefs relating to possessing mastery and being free from constraints. However, in study 5 a modified, better focused, version of the Crick essay successfully undermined control beliefs relating to notions of having control over one's actions and decisions. We suspected that this modified version of the Crick essay still retained some of the limitations of the original by lacking focus and directly mentioning free will. Clearly, we needed to develop a more powerful, better focused yet implicit manipulation of belief in free will.

Study 6 aimed to construct a new better focused yet implicit manipulation and compare its ability to undermine free will beliefs to that of the Crick essay. Our new manipulation harnessed transcranial magnetic stimulation (TMS) to undermine participants' perceptions of possessing free will by impacting their ability to execute a volitional action (drinking a glass of water). Participants reading the Crick essay reported significantly lower post manipulation free will scores (controlling for the pre-manipulation scores) than participants in the neutral condition. The TMS manipulation failed to significantly reduce free will beliefs compared to the neutral condition.

Although the TMS manipulation did not successfully impact free will beliefs, compared to the neutral condition, a comparison of participants pre- and post manipulation free will scores highlighted significant within condition reductions for all three conditions. We explored research that hints at a potential explanation for why a statistically significant reduction was observed in participants pre-and post-manipulation free will scores in the neutral condition. This explanation centres around context effects. Specifically, we argued that the intimidating effects of awaiting to undergo TMS may have undermined participants sense of feeling free. This effect would have exerted its influence predominantly in the Crick and neutral conditions.

In study 6, Participants in the Crick condition also reported their perceptions of what the main points of the Crick essay was. Their responses

further demonstrated the unfocused nature of the Crick essay and highlighted its potential to induce demand characteristics.

For study 7 we decided to try a different approach that would allow large scale data collection without needing to bring participants in to the TMS lab. We decided to follow the recommendation of Schooler et al. 2014 and create a manipulation that was broad ranging and hard-hitting. We did not attempt to employ framing effects by deceiving the participants into believing that the manipulation and dependent measures were parts of separate studies as this strategy had not been successful for Nadlehoffer et al. (2019) when used online.

In study 7 we designed and tested a second new manipulation in the form of a pro deterministic and a nondeterministic video lecture. This new manipulation successfully undermined belief in free will (despite never mentioning it) but did not directly undermine belief in self efficacy or our two measures of control. Unsurprisingly message agreement moderated the impact of condition on all 4 criterion variables and education level moderated the impact of condition on our 2 measures of control. Our exploratory analysis explored the impact of condition on self-efficacy, both directly and via free will beliefs and control; with these relationships moderated by message agreement. As expected, both measures of control better mediated the impact of condition on self-efficacy than free will beliefs. When participants in the deterministic condition disagreed with the content of their video, they

demonstrate incompatibilist tendencies (and possible reactance effects, (Brehm 1966) by reporting higher levels of the 4 criterion variables. When they agreed with the deterministic video, they reported lower levels of free will and control over their actions and decisions. This effect was not observed for participants sense of having mastery and being free from constraints. Agreement with determinism also predicted lower self-efficacy indirectly via participants sense of having control over their decisions and actions. Surprisingly participants exposed to the non-deterministic lecture demonstrated significantly more cheating than participants exposed to the pro deterministic lecture.

Our findings and their contribution to the literature.

Just how broad ranging are anti free will/pro deterministic manipulations? In study 6 (chapter 6) participants self-reported understanding of the Crick essay (Crick, 1994), demonstrated for the first time just how wide ranging and unfocused this manipulation is. Participants saw the Crick essay as simultaneously attacking religious ideology, undermining free will beliefs, and promoting deterministic arguments. As most modern anti free will/pro determinism manipulations appear to be equally broad ranging, better more focused manipulations should be developed. We will return to that subject later.

Items designed to measure free will and determinism appear to be equally broad ranging (see chapter 1) potentially lacking the focus necessary

to pick apart the relationships between lay notions of free will and potentially confounding, overlapping or secondary concepts such as choice, control and moral responsibility. We aimed to create more focused single item measures that would help us test these relationships.

Single item measures have grown in popularity over the timescale of this research project. They have demonstrated good convergent (Schooler et al., 2014) and predictive (e.g., Feldman et al., 2016) validity, and single-item free will measures have been shown to be sensitive to experimental manipulations of free will beliefs (MacKenzie et al., 2014; Nahmias et al., 2014; Monroe et al., 2017). In study 1 We successfully created and began validation on a new slider measure of free will and new slider measure of scientific determinism.

The single item free will measure that directly mentions free will was designed to elicit only the individuals lay free will concept rather than imposing the researchers understanding on the participant. Our new slider measure of free will successfully predicted indicators of subjective well-being before participants ratings of control were entered into the model in study 2 (chapter 4). This measure also proved to be susceptible to a pro determinism manipulation (study 7 in chapter 7). In study 6 (chapter 6) it also proved susceptible to a manipulation that contained both anti free will and pro deterministic elements (Crick essay) and our new implicit TMS manipulation (when pre and post manipulation free will scores were compared). Our single

item free will measure demonstrated convergent validity, correlating positively with the free will subscale of the FAD-Plus (Paulhus and Carey 2011) in study 1 (chapter 1), both measures of control and self-efficacy (study 7 chapter 7) and a measure of divergent validity via its negative correlation with the scientific determinism subscale of the FAD plus. We therefore see the development and testing of our single item measure of free will as a modest but potentially useful contribution to the literature.

Our single item measure of scientific determinism demonstrated some convergent validity by correlating positively with the scientific determinism subscale of the FAD plus (Paulhus and Carey 2011). We did not decide to use this measure in future studies as we felt that while a single item measure of free will can tap directly into the lay beliefs of a given individual (whatever that might be), a single item measure of determinism can only fail to capture the complexity and breadth of contemporary deterministic arguments. In every day life we encounter deterministic arguments wrapped up in common narratives. Narratives about the influence of genetic inheritance and childhood environment on personality, narratives that celebrate the ability of scientific causal principles to explain all human behaviour. These accessible every day narratives may be better expressed by multi item measures of determinism such as the FAD-Pluss (Paulhus and Carey 2011) or to tap more philosophical understandings of determinism, the free will inventory Nadelhoffer et al., (2014). However, as we will discuss later, if the impact of

determinism on cognitions and behaviours is to be better explored new instruments will need to be developed that can delineate between the various types of deterministic belief.

Study 1 tested our new single item measures of free will and scientific determinism and compared them to their well validated multi item counterparts from the FAD-Pluss. There was no consistent reliable relationship displayed across both measures of free will when compared to both measures of scientific determinism. Although our study was limited to 80% power to detect medium effect sizes or greater, our findings concur with previous work that had 80% power to detect small effects (Paulhus & Carey 2011). These findings are in line with other research suggesting that lay participants do not always see free will and determinism as incompatible (Nahmias, Morris, Nadelhoffer & Turner, 2006; Nichols, 2006; Nichols & Knobe, 2007; Murray & Nahmias, 2014; Shepherd, 2012). So although a certain amount of lay incompatibilism may exist it lacks sufficient reliability to warrant experimental manipulations such as the Crick essay and Velten (1968) style manipulation (introduced by Vohs and schooler 2008 and discussed in chapter 2) that include both anti free will and pro deterministic messages in the same condition. Researchers should also avoid the practice of combining free will and deterministic subscales that were designed to measure separate constructs (see Lynn, Van Dessel & Brass, 2013; Rigoni, Wilquin, Brass & Burle, 2013 for examples). We acknowledge however that in some of the examples

just cited researchers' interest was less in free will as a concept and more in the extent to which the participants perceived themselves to have intentional control.

What are lay free will beliefs? Across studies 1 (chapter 3) and 3 (chapter 4) we conducted 2 qualitative analysis of participants free will definitions. In general, Lay participants ascribed to a psychological rather than metaphysical definitions of free will centring around perceived Choice capacity and freedom from constraints. This confirmed past research by Monroe and Malle 2010; 2014). In addition to directly asking people to define their free will beliefs, we used our better focused single item measure of lay free will to investigate which factors correlate with lay free will belief. This could then provide new insight into participants' underlying conceptions of free will. In study 7 (chapter 7) we compared this slider measure of lay free will beliefs to 2 measures of choice/control that were designed to emulate the underlying concepts that free will beliefs tap. In study 7 (chapter 7) our new measure of free will beliefs correlated more highly with a measure of control relevant to perceived decision making and control over actions (.71**) than with a measure of control relevant to people's perceptions of having mastery and being free from constraints (.37**). These relationships remained consistent regardless of experimental condition.

Lay concepts of free will require choices to be free from constraints (Monroe & Malle, 2010; 2014 and studies 1 and 2). The qualitative free will

definitions provided by participants in studies 1 and 2, demonstrated that these constraints are largely external in nature, predominantly representing constraints on choice from others. Finding that free will ratings more closely match understandings of control relevant to decision making and control over actions than to personal mastery and freedom from constraints, would seem to suggest that perceived constraints were less important. We suspect however that when participants are asked to "Please indicate the extent to which you believe that you have free will" (as with our single item slider measure) they may draw on perceptions of their own capacity to make choices and decisions. However, when asked "*please explain in a few lines what you think it means to have free will*" (as with the qualitative free will definitions questions) participants may draw on real world scenarios involving others, increasing the role of perceived constraints. This last observation is of course speculative but warrants further investigation. An investigation to explore the differing elements of choice and control that underpin lay free will concepts could involve the creation of a specific instrument. A second strand of research could involve priming participants with either a social scenario (likely to promote cognitions centring around potential constraints from others) or a non-social scenario (likely to promote cognitions around individuals control over their capacity to make decisions and choices). One obvious difference between the language we use to explain the core concept of lay free will belief and that of Monroe and Malle, (2010) is that we discuss

lay free will belief in terms of perceived capacity for control while they see it as the capacity to make choices that fulfils desires, free from constraints. We see these conceptualisations as very similar in that to us, a choice that is not constrained by others equates to a successful act of control.

Does perceived control underpin the relationship between free will beliefs and life outcomes? The most widely used measures of free will beliefs appear to be broad ranging including items measuring morel responsibility, choice and control (see Paulhus and Carey 2011; Rakos et al., 2008 and chapter 2). We suspected that it was this element of perceived choice/control, inherent in both these measures of free will, that was responsible for predictive utility for free will beliefs to predict indicators of subjective wellbeing (Crescioni et al., 2015; Li et al.,2017). In a published paper, studies 2 and 3 (chapter 4) demonstrated that our single item measure of lay free will beliefs had the same utility as the multi item measures, for predicting indicators of subjective wellbeing. However, when our measure of lay free will beliefs was entered into a model simultaneously with a measure of control, only perceived control successfully predicted life outcomes. There was no remaining role for free will beliefs in predicting subjective wellbeing, beyond free will's covariation with perceived control. This was true of both trait measures of free will and control (study 2) and daily state measures (study 3). Finding that it is the element of choice control within free will beliefs that predicts subjective wellbeing is a new contribution to the literature. These

findings could be refuted or confirmed using new or existing data by conducting a factor analysis on the items from the free will subscale. If distinct factors emerge withing the free will subscale centring around choice/control and moral responsibility, these factors could be split into discreet variables and these variables used to predict subjective wellbeing or other myriad life outcomes associated with free will beliefs (Crescioni et al.,2015; Li et al.,2017).

The role of perceived control in anti free will manipulations. In the previous section we described how the overlap between free will beliefs and notions of possessing choice and control (key elements of most widely used free will measures) is responsible for the utility of free will beliefs to predict subjective wellbeing. Chapter 2 also outlines the breadth of the Crick essay and Velten style manipulator, introduced by Vohs and schooler, (2008). As with the correlation-based studies, we suspected the ability of these often used manipulations may be better understood by their impact on perceptions of control rather than their impact on free will beliefs. We further theorised that we may even be able to impact cognitions relevant to the appraisal of subjective well-being by targeting perceived control with the Crick essay.

To begin this line of enquiry we first tested the impact of the Crick essay on perceived control. To our surprise the Crick essay was not able to impact control beliefs pertaining to participants sense of having mastery and being free from constraints (Chou et al., 2016). This conceptualisation of control had proven successful in study 2 (chapter 4) in demonstrating that

free will belief's capacity to predict subjective wellbeing is based on free will beliefs covariation with perceptions of choice and control. After modifying and focusing the Crick essay it successfully impacted notions of control relevant to perceived decision making and control over actions. Finding that an often used free will manipulation can also impact perceptions of control was new to the literature; although it must be stated that this manipulation was only successful in its modified (abridged) form that contains only key sections from the original but does not add any new text. Even in its modified form the Crick essay explicitly stated that free will does not exist, risking substantial demand characteristics. Participants qualitative evaluations of the Crick essay (study 6 chapter 6) confirmed that the Crick essay risks demand characteristics and demonstrated the Crick essay's broad and unfocused nature.

This line of reasoning prompted us to create two new manipulations, designed to better target/undermine perceptions of choice control and free will without the tendency to prompt demand characteristics that may be inherent to the current text based manipulations (see study 6 chapter 6).

Manipulation 1, TMS

In study 6 (Chapter 6) we aimed to undermine free will beliefs by impacting participants ability to execute a volitional act (drinking a glass of water). This approach had the advantage of being language free, impacting free will by undermining participants ability to control their own mental processing and

ultimately their bodies. The obscurity of this manipulation led to reduced participant suspicion compared to the Crick essay even when participants were extensively probed for awareness. Although the TMS manipulation failed to reduce free will beliefs relative to the neutral and Crick conditions a statistically significant reduction in free will beliefs was observed between TMS participants pre-and post-manipulation scores. One possibility, backed up by some previous literature (Ent, 2013; Laurene et al., 2011) is that participants anxiety at being placed in a stressful lab environment (while awaiting TMS) may have disproportionately lowered the post manipulation free will scores of participants in both the Crick and neutral conditions. Future research could both test for and capitalise on this effect. In a potential study, participants could be asked to complete self-report measures of free will and choice/control in the comfort of their own home. One group of those participants would retake the self-report measures in the comfort of their own home (no intimidation condition). A second group would come into the University and retake the self-report measures in the comfort of the psychology department waiting room (low intimidation condition). The final group would be asked to retake the self-report measures while sitting in the intimidating TMS lab surrounded by the full range of intimidating TMS equipment and expecting to have to complete a TMS experiment.

Manipulation 2, video lectures

For study 7 (chapter 7) we wanted to create a manipulation that was focused, targeting just determinism, yet following the recommendation of schooler et al. (2014) also broad, enlisting a wide range of popular deterministic arguments (see Harris, 2012; 2013). To reduce demand characteristics and test for lay Incompatibilism we manipulated determinism yet measured free will beliefs, control and self-efficacy. This manipulation took the form of a deterministic video lecture and a non deterministic lecture on consciousness. The deterministic lecture successfully undermined free will beliefs without mentioning free will, which we believe to be a new contribution to the literature yet failed to undermine perceived control or self-efficacy. Participants who agreed with this deterministic video also reported reductions in control relevant to perceptions of being in control of their choices and decisions. Agreement with the deterministic lecture predicted reduced Self-efficacy but only indirectly via participants sense of having control over their decisions, choices and actions We believe this finding to be new to the literature.

This research project succeeded in its aim to construct an enhanced manipulation of belief in determinism that addresses many of the theoretical limitations of the text based approaches typically used such as the (Crick, 1995) and Velten (1968) style manipulations. However, as we will discuss

bellow this manipulation may have been too powerful and too challenging prompting reactance effects (Brehm (1966).

The impact of reactance and demand characteristics and how best to manage them. Reactance (Brehm 1966; Miron & Brehm, 2006) is a person's drive to resist perceived threats to their sense of being a free agent, able to behave as they choose. People's understanding of what it means to have free will includes an element of not being constrained in their choices (Monroe & Malle, 2010; 2014). Such perceptions are also likely fundamental to peoples' sense of identity and challenges to these perceptions, via pro deterministic manipulations aimed at undermining belief in free will, are likely met with reactance from participants. Researchers have begun to note the importance of managing/reducing potential reactance when manipulating participants free will beliefs (Protzko, Ouimette & schooler, 2016; Schooler, 2014). Measures of trait reactance have successfully moderated the impact of an anti free will/pro determinism manipulation on pro social behaviours, with those scoring high on trait reactance proving significantly more helpful after reading an anti free will/pro determinism text, than participants exposed to a neutral text (Ent, 2013).

In study 7 reactant participants appeared to not only resist the intended manipulation but to even respond in a manner, opposite to the intended demands of the manipulation, A significant main effect was observed for the direct effect of condition on self efficacy (model 1 study 7),

with participants in the deterministic condition reporting higher levels of self efficacy than those exposed to non-determinism. The capacity for pro deterministic manipulations to prompt reactance had been documented in the literature. For example, compared to those reading the neutral text, participants high in trait reactance reported lower belief in determinism after reading a pro determinism/anti free will text (Ent, 2013).

Study 7 (chapter 7) adds to these findings, demonstrating that broad ranging, hard hitting pro deterministic manipulations can prompt reactance that must be controlled for. In our view this requires the employment of two strategies. Firstly, the framing effects introduced by Schooler et al. (2014) should be incorporated into the research design. Framing effects involve a form of harmless deception, whereby the manipulation and the dependent measures are presented to participants as parts of two separate studies. This approach has proven successful for Vohs and Schooler (2008) in the lab and has been partially successful (manipulating free will beliefs but not cheating) online (Schooler et al., 2014). Other researchers have not found that these framing effects lead to successful manipulations of free will belief and cheating when used on line (Nadelhoffer et al., 2019). The second strategy, successfully employed by (Ent, 2013) is to include a measure of trait reactance (Hong & Faedda, 1996). We suspect that the deterministic, anti free will manipulation that we introduced in study 7 was so challenging to participants that it would prompt a reactant response even in those who are not

necessarily high in trait reactance. Paradoxically then our manipulation may prove more successful if weakened. We will also continue to include a measure of message agreement that allows us to predict outcomes using participants agreement with deterministic/none deterministic content, as a proxy for their views.

If measures to reduce or control for reactance prove unsuccessful then correlation based approaches could be used but these also come with challenges. The most significant of these being that better educated individuals are more likely to have prior learning of the various strands of hard determinism. Such well educated individuals are likely to be smart enough to score highly on measures of self-efficacy and perceived control. The challenges of controlling for this may prove to be considerable. Additionally researchers would need to measure participants knowledge of the various elements of hard determinism in order to discover which elements of deterministic beliefs predict self-efficacy (study 7 chapter 7), subjective wellbeing (Crescioni et al., 2015; Li et al., 2017) and educational achievement (Feldman et al., 2016) etc.

For now, the manipulation of deterministic beliefs may prove more fruitful than correlation based approaches, here again the challenge of recording participants deterministic belief without prompting demand characteristics is a considerable one. In study 7 (chapter 7) we did not record

deterministic beliefs due to our concern over prompting demand characteristics. Instead we measured control and free will.

The modest negative correlation between our single item measure of lay free will beliefs and the multi item measure of scientific determinism from the FAD-Plus (Paulhus and Carey 2011) (study 1) gave us confidence that our pro determinism lecture would undermine belief in free will. In study 1 we wanted to demonstrate that the Free will and scientific determinism scales of the FAD-Plus did not negatively correlate in order to demonstrate that combining these scales together was unwise. We also wanted to see if our single item measures of free will and scientific determinism would also display a negative relationship in order to add weight to the argument that belief in free will is not always incompatible with belief in determinism. (Nichols & Knobe, 2008, Nahmias, Morris, Nadelhoffer & Turner, 2006). We did not assume that our single item measure of lay free will would not correlate negatively with the scientific determinism scale of the fad plus. Indeed, the modest but significant negative relationship between our single item measure of lay free will belief and the scientific determinism scale of the FAD-Plus led us to incorporate similar arguments into our deterministic video lecture.

Returning to study 7, we decided to record the impact of determinism on measures of control because it was determinisms capacity to impact control that was of interest rather than beliefs in determinism per se.

In future studies we aim to create a series of single item measures that tap the various constituents of our broad deterministic manipulation. To control for demand characteristics, we must first identify participants likely to be susceptible to them. Demand characteristics can lead to a number of undesirable effects. Of most relevance to research in this field is the potential for participants to figure out the intentions of researchers and provide the responses that they think the researcher is seeking. This wish to please could be used to identify participants who responded to the manipulations by giving what they perceived to be the 'correct response'. One strategy could be to use demand characteristics to identify demand characteristics by asking whether participants allowed their beliefs about the researchers' intentions to colour their responses. Demand characteristics could be explained to participants as a form of 'Participant kindness', from those participants 'intelligent enough to deduce the researcher's intentions'. This strategy should encourage those participants keen to please the researcher, to please the researcher by self reporting on any 'helpful' responses that they were consciously aware of giving.

The impact of determinism/non determinism on cheating

Vohs and Schooler (2008) were the first to report that manipulating free will beliefs could increase cheating behaviour. Their study was conducted in the lab. We aimed to create and test a new quick and simple measure of cheating that can be used online. In study 1 chapter 1 this measure demonstrated a

good bassline level of cheating. In study 7 (chapter 7) exposure to a non-deterministic video lecture resulted in significantly more cheating than exposure to a pro determinism video lecture. This result was unexpected both in terms of finding a significant between condition difference and in terms of the direction of the effect.

A successful manipulation of cheating via a pro deterministic/anti free will manipulation contradicts the majority of the literature that has seen most attempts to replicate Vohs and Schooler (2008) fail (Giner-Sorolla et al., 2015; Nadelhoffer et al., 2019; van den Brink, 2016); despite a likely publication bias in favour of successful replications over unsuccessful attempts. Schooler et al. (2014) has reported some successes in replicating the findings of Vohs and Schooler (2008) but these successes were inconsistent. Our finding, that participants in the non deterministic condition cheated more could be down to our decision to manipulate only determinism while not mentioning free will beliefs. This explanation seems unlikely however as our pro determinism manipulation did impact free will beliefs.

In study 7 participants exposed to a non-deterministic account cheated more (by making a false claim, in order to avoid providing a short written text) than participants exposed to a pro deterministic account. This finding is new to the literature however there are examples in the literate where exposure to deterministic arguments has reduced behaviour that many would consider antisocial. For example Caspar et al. (2017) found that participants exposed to

the Crick essay manipulation displayed less vindictive behaviour by administering fewer electric shocks to a confederate. This only held true for female participants. In another study believing in free will has been shown to predict acceptance of economic inequality (Mercier, n.d). Due to the lack of a third experimental condition it is impossible to say whether the deterministic video lecture reduced cheating or the non deterministic video lecture increased cheating. It is challenging to find president or explanation for either possibility.

In so far as the manipulation successfully impacted cheating our cheating measure proved a success. However, it is possible that some participants may have felt aggravated by the deterministic video lecture. This could have led them to feel less inclined to assist the researcher by providing the requested information. They may have chosen instead to falsely claim that they had heard of our fictional organisation rather than offer the requested marketing feedback. Such effects are a risk to any cheating measures where the participants are required to perform a task for, or claim reward from, a researcher as a test of cheating. Please see Nadelhoffer et al. (2019), Schooler et al. (2008), Schooler et al. (2014), van den Brink et al. (2016) for examples of the various tasks that have been used to demonstrate cheating behaviour after an anti free will/pro determinism manipulation. Of course a tendency for participants to cheat more in the anti free will/pro determinism condition would have diminished, not increased the experimental effect found in study

7. Although not an issue in study 7 this scenario highlights the need to introduce framing effects by telling participants that the manipulations and dependent measures are parts of separate studies. If successful, framing effects should reduce the likelihood of any potential irritation with researchers who challenge closely cherished beliefs, being carried over to the dependent measures.

Conclusion

Current free will manipulations and measures are overly broad containing elements relevant to free will, choice/control and moral responsibility. This breadth has made it difficult to discern just how (and indeed if) free will beliefs impact cognitions, beliefs and behaviours.

First we confirmed past findings demonstrating that perceptions of having choice and being free from constraints are central to lay understandings of free will. We then looked at correlation based research using our new better focused, single item measure of lay free will to demonstrate that it is the element of choice control within free will beliefs that predicts indicators of subjective wellbeing.

We then turned our attention to the area of research that aims to impact behaviours and beliefs by modulating belief in free will. We theorised that often used free will manipulations are actualy impacting cognitions beliefs and behaviours by undermining perceived choice. We demonstrated that an abridged version of one such manipulation (the Crick essay), does

indeed undermine perceptions of control relevant to decision making and control over actions. However, these text based manipulations lack focus and prompt demand characteristics so we developed 2 new manipulations that address those limitations.

Our TMS manipulation led to a significant reduction between participants pre and post manipulation scores. Our video lecture manipulation was designed to modulated deterministic belief. It demonstrated lay incompatibility by successfully undermining free will belief but perceived control and self-efficacy were not impacted. We also created a new online cheating measure. To our surprise exposure to a deterministic argument led to less cheating than exposure to a non-deterministic argument.

We also conducted exploratory work. Agreement with determinism (compared to non determinism) predicted reduced free will beliefs and reduced perceptions of control relevant to decision making and control over actions. We found evidence suggesting that relative belief in determinism may undermine self efficacy via its impact on self control and that perceived control better mediates the impact of relative belief in determinism on self-efficacy. These exploratory findings are tentative, more work is needed to establish that deterministic beliefs impact cognitions beliefs and behaviours and self-efficacy by undermining perceived control. The combined evidence from this research project suggests that this work should harness a broad hard hitting deterministic argument while controlling for participants

reactance and demand characteristics. Once the capacity for deterministic belief to impact cognitions beliefs and behaviours has been established new tools should be developed to discern which aspects of deterministic belief undermines perceived control.

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Appendix

Appendix chapter 3

Appendix: 1

Coding instructions for lay free will definitions.

The categories of *decision/choice, following desires and overcoming internal and external constraints* drew heavily on the coding instructions from Monroe and Malle (2010). The other categories were novel.

Philosophical= A statement that alludes to the philosophical debate around free will and determinism and suggests that free will offers people some kind of immunity from causation. Free will definitions that are coded as philosophical should describe some ability of the individual to make decisions or act without the constraints of the causal laws that produce both our universe and our physical brains.

Control= directly mentioning the word "**control**" or "**controlling**" or "**controlled**". etc.

Choices = directly mentioning the word "**choice**" or "**choosing**" etc.

Decide = Directly mentioning the word "**decide**" or "**deciding**" or "**decision**" etc.

Action = Directly mentioning the word "**act**" or "**action**" or "**acting**" etc.

Future plans = Statements that refers to future outcomes. Possible examples would be "**choose my own course in life**" or "**bring about the outcomes I want**". This is more a matter of understanding meanings than simple word identification.

Following desires= Statements that demonstrate peoples wish to express themselves. Statements such as "**doing what you want**" or "**acting as I please**" "**freedom to be me**" "**freedom to believe what I want**" are examples of people following their desires.

Overcoming constraints = Statements that refer to a person's ability to resist external or internal influences on behaviour such as physical limitations or social demands. This includes coercion or pressure from others and can be expressed by statements like "**Not being forced by others**" or "**without anyone stopping you from doing it**" **or no one can make you**" or "**not needing permission**"

Awareness of consequences to actions = Statements that demonstrates an awareness that actions may lead to reactions/consequences from others. Mentioning "**responsibility**" or "**be prepared to accept the consequences**" or "**do whatever you want just don't harm another person**".

Appendix: 2

Free will definitions that were coded as philosophical.

1. Having the freedom to make decisions without it being predetermined for you
2. My actions have not been pre determined, nor has the outcome of any follow on effect been predermined
3. I think it's an invalid philosophical concept, but most generally mean it in the sense of either: a) an individual being responsible for his/her actions; b) choices not being either strictly determined by prior causes, or random.
4. To be able to decide on a choice without having been forced into a decision beforehand by some unforseen force
5. Where one's thoughts are non-physical in origin and can alter things without predetermination
6. Free will means not to be able to ascribe a person's or an animal's choice(s) to any external factor by a rational-mechanical way of causation.
7. I have free will when I'm able to make my own decisions without things being predetermined!

Appendix chapter 5

Appendix: 3

Modified (shortened) version of the anti free will essay from *The Astonishing Hypothesis* by Francis Crick (1996) used in Study 5

Anti free will condition

Please carefully read and consider the essay on the following page, which was written by Francis Crick.

Francis Crick is the British physicist and biochemist who collaborated with James D. Watson in the discovery of the molecular structure of DNA, for which they received the Nobel Prize in 1962. He is the author of *What Mad Pursuit, Life Itself*, and *Of Molecules and Men*. Dr. Crick lectures widely all over the world to both professional and lay audiences, and is a Distinguished Research Professor at The Salk Institute in La Jolla, CA. Dr. Crick's essay (on the next page) comes from *The Astonishing Hypothesis*.

Please read the following short essay carefully because you will be asked to summarize its details later in the survey.

The essay is not long, so please read it before continuing.

"You," your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules. Who you are is nothing but a pack of neurons.

Most people take free will for granted, since they feel that usually they are free to act as they please. Three assumptions can be made about free will. The first assumption is that part of one's brain is concerned with making plans for future actions, without necessarily carrying them out. The second assumption is that one is not conscious of the "computations" done by this part of the brain but only of the "decisions" it makes – that is, its plans, depending of course on its current inputs from other parts of the brain. The third assumption is that the decision to act on one's plan or another is also subject to the same limitations in that one has immediate recall of what is decided, but not of the computations that went into the decision.

So, although we appear to have free will, in fact, our choices have already been predetermined for us and we cannot change that. One's self can attempt to explain why it made a certain choice. Sometimes we may reach the correct conclusion. At other times, we will either not know or, more likely, will confabulate, because there is no conscious knowledge of the 'reason' for the choice. This implies that there must be a mechanism for confabulation,

meaning that given a certain amount of evidence, which may or may not be misleading, part of the brain will jump to the simplest conclusion.

Control condition (consciousness)

Modified (shortened) version of the essay on consciousness from *The Astonishing Hypothesis* by Francis Crick (1996) used in Study 5

Please carefully read and consider the essay on the following page, which was written by Francis Crick.

Francis Crick is the British physicist and biochemist who collaborated with James D. Watson in the discovery of the molecular structure of DNA, for which they received the Nobel Prize in 1962. He is the author of *What Mad Pursuit, Life Itself*, and *Of Molecules and Men*. Dr. Crick lectures widely all over the world to both professional and lay audiences, and is a Distinguished Research Professor at The Salk Institute in La Jolla, CA. Dr. Crick's essay (on the next page) comes from *The Astonishing Hypothesis*.

Please read the following short essay carefully because you will be asked to summarize its details later in the survey.

The essay is not long, so please read it before continuing.

Psychologists have shown that common sense ideas about the working of the mind can be misleading. When psychology began as an experimental science, in the latter part of the nineteenth century, there was much interest in consciousness. It was hoped that psychology might become more scientific by refining introspection until it became a reliable technique.

The American psychologist, William James, discussed consciousness in his work 'The Principles of Psychology' (1898), and described five properties of what he called "thought". Every thought, he wrote, tends to be part of personal consciousness. Thought is always changing, is sensibly continuous, and appears to deal with objects independent of itself. In addition, thought focuses on some objects to the exclusion of others. In other words, it involves attention. Of attention he wrote, "It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. It implies withdrawal from some things in order to deal effectively with others."

Unfortunately, since James, a movement arose in academic psychology that denied the usefulness of consciousness as a psychological concept. This was partly because experiments involving introspection (which involves thinking about what one is thinking) did not appear to be leading anywhere and partly because it was hoped that psychology could become more scientific by studying behavior that could be observed unambiguously by the

experimenter. This was called the Behaviorist movement. It became taboo to talk about mental events. All behavior had to be explained in terms of the stimulus and the response.

Appendix chapter 6

Appendix: 4

Post experimental interview form (Suspicion checker)

Name……

Email address……

Debriefing Questions

1. Do you have any questions about the experiment?

   ……

   ……

2. Was the purpose of the experiments clear and did all aspects of the procedure make sense?

   ……

   ……

3. People react to things in different ways. It would be helpful to hear about your feelings and reactions to the experiment, the reasons for your responses and so on.

   ……

   ……

4. Was any aspect of the procedure odd, confusing or disturbing?

   .....

   .....

5. Do you think there may have been more to the experiment than meets the eye?

   .....

   .....

   What do you think the purpose was of the experiment? What do you think we wanted to learn about?

   .....

   .....

6. In psychology research we sometimes need to use deception, that is, we occasionally mislead people about the purpose of our research or aspects of the procedure. This is often necessary if we are to understand how people think and behave in the real world. Do you think there was any element of deception in the present study?

   .....

   .....

   N or S

Appendix: 5

Content coding for participants' responses to the meaning of the Crick essay.

Pro science: Column name = **Pro_Science**

To be classed as **pro science** participants must interpret the essay as championing science with phrases like "showing that science has the answers".

Anti myth or Religion: Column name = **Anti_Myth_or_Relegion**

When participants interpret the essay as arguing against or disproving religious beliefs or myths (e.g. "science has disproven religious myths" or "that religion is wrong") responses are coded as Anti myth/religion.

Anti myths Column names = ***Anti_Soul Anti_Afterlife Anti_Fee_Will***
Claims of the nonexistence of specific aspects of mythical/ religious ideologies (e.g. Souls, Afterlife, Free will) should be coded according to the term used and sorted into the relevant column.

Anti choice or reductionist: Column name = **Anti_Choice_or_reductionism**
Anti choice or reductionist understandings of the essay view it as claiming that our choices are limited or controlled by our brains, genes, environment , DNA, or some other factor (e.g "we a do don't choose as all our choices are made by our brains and neurons") these interpretations of the essay can either state that choices are constrained or just reduce human decision making down to biological neuronal processes.

Pro free will: Column name = **Pro_Free_WIll**
Pro free will interpretations of the essay will state that the essay was arguing that free will exists.

Free will neutral: Column name = **Free_Will_Nutral**

Interpretations of the essay that mention free will l but do not claim that the essay was arguing in favour or against free will should be coded as free will neutral.

Appendix chapter 7

Appendix: 6

Voice over scripts for video lectures.

Deterministic condition (deterministic video lecture)

Like Einstein, most modern scientists believe in the theory of Determinism. Determinism teaches us that everything that happens in the universe was determined (meaning caused to happen) by events that happened before. This includes all of our choices. Your conscious self does not actually make your choices rather your brain makes all your decisions for you and then generates your consciousness experiences. So, although you feel like you consciously make choices, those choices were all determined by your brain. The choices that your brain makes were all pre-determined and inevitable.

Let me take you through the science in a few simple steps. The science of Determinism draws on the fact that we live in a cause and effect universe. Living in a cause and effect universe means, Firstly, that nothing can happen without being caused. So everything that happens must have been caused to happen. The first domino can only fall if it is caused to, perhaps by a finger pushing it or it being knocked or shaken. Secondly, things that happen then cause other things to happen. So the first domino falling caused the next domino to fall. An action will always lead to consequence even if that

consequence is just the final domino lying flat rather than being upright. Everything that happens in the universe has causes, and things that happen then cause other things to happen.

Think of snooker balls bouncing off each other. Each ball only starts moving as a result of being struck and then that ball goes on to strike other balls, also moving them. These balls then collide with other balls and this cause and effect process continues.

Importantly, if someone knew the exact position and angle of movement of all the snooker balls at the start of their interaction, it would be possible to calculate their interactions from then on. Even if the balls somehow kept on moving for a thousand years, their eventual position would be inevitable, fixed. Their eventual position could be said to have been pre-determined, because once those balls were set in motion the mechanical cause and effect nature of our universe means that there was only ever one way that the final arrangement of balls was going to turn out. That is determinism in a nutshell.

The universe, although vastly bigger and more complex than a snooker table, works in exactly the same mechanical cause and effect way. In 1814 The famous mathematician Pierre-Simon Laplace realised that if we knew the position and movement of every particle and atom at the start of the universe,

just after the big bang, we could “theoretically” predict everything that those atoms were going to do from that point on.

We could “theoretically” predict exactly how those atoms would move, interact and combine to form stars, planets, life forms, and eventually you, your DNA, your brain and every event that will happen to you in your lifetime. We would know your past, your present and your future because your future is set, fixed and inevitable. Just like the snooker balls, once the atoms that make up our universe were set in motion there was only one way that the universe was ever going to turn out. And guess what, you are a part of that universe so that includes you.

That is because your brain is entirely physical in nature, a product of our physical universe, processing information via the physical movement of atoms and molecules. So, just like everything else in the universe, your physical brain, the way it processes information and even the decisions it makes were entirely pre-determined (caused) by prior events stretching all the way back to the big bang. Even your conscious experience is a pre-determined product of processing in your physical brain because your brain generates your consciousness.

Therefore, from the beginning of the universe 13.82 billion years ago, every thought and feeling that you were are going to have and every choice and

decision that you are ever going to make was fixed, inevitable, predetermined to happen in just one way. From the formation of the universe you were always going to be where you are right now watching this video, thinking exactly what you are thinking now.

So how do we know that our thoughts, feelings and decisions are all made by our brain and are predetermined. Could they not be driven by our consciousness somehow? Scientists like Benjamin Libet have proven that our consciousness does not actually make our choices, rather our brain makes our decisions for us and only then generates our conscious experience of making that decision. Our feeling of consciously making a decision is just an illusion.

brain Even when you feel like you are making a complex decision by carefully weighing up multiple options your brain is generating your conscious experience of the process a fraction of a second after it does the actual processing. ultimately your consciousness is a mere bystander observing brain processing that was all predetermined and inevitable.

Our brains really do make our decisions for us. Research shows that advanced brain scanners can now observe your brain making a decision to move your hand, seconds before you even become consciously aware of that decision. In other research brain stimulation devises have actually controlled what hand a person chooses to move while the person remained completely unaware that they have been influenced.

All of our thoughts, feelings, decisions and even our conscious experiences of making those decisions were fixed, predetermined and inevitable from the moment of the big bang. Everything that is going to happen to you and every decision you are ever going to make in the future is also set. There is nothing that we can do to change that and anything that we try do any any seemingly random action or new behaviour, well that was also pre-determined. We are like movie characters half way through a film, we may not know the ending but ultimately our script has already been written.

To conclude then, modern science supports Determinism. Determinism teaches us that we are not really in control of our choices, decisions and actions. Rather all our thoughts, feelings and decisions are made, not by our consciousness, but by our brains. All of our brains decisions were pre-determined from the moment of the big bang and are completely inevitable. Our past present and futures are predetermined and fixed.

Non deterministic condition (consciousness video lecture)

Over the decades leading Scientists like Einstein have steadily added to our understanding of the universe. From its beginnings, to the formation of its galaxies, stars and planets, to the eventual development of complex life, the brain and even some aspects of human behaviour, scientists have been able to steadily fill in the blanks to reveal a clearer picture of our existence. One issue, however, both tantalises and frustrates human inquiry and although some progress has been made, the question of how we actually experience human consciousness may prove our most elusive mystery.

Let me take you through our scientific progress in a few steps. All scientific theories draw on the fact that we live in a cause and effect universe. This means that when things happen, they often go onto cause other things to happen. So, the first domino falling causes the next domino to fall. Actions lead to consequences and if the nature of the relationships involved are known, we are able to make predictions about what will happen next. We will know for example that if the dominoes are positioned correctly, pushing the first one will lead to all of the dominoes eventually falling in a predicable fashion. We can predict the future and ask testable questions “or hypothesis” based on what we know about the objects involved and the laws of physics that govern their interactions.

Think of snooker balls bouncing off each other. Each ball starts to move move as a result of being struck and then goes on to strike other balls, also moving them. These balls then collide with other balls and this interaction continues in a predictable fashion.

The trillions of atoms in our universe interact with each other much like the snooker balls. On a small scale they act according to the laws of quantum mechanics, on a larger scale, classical physics. Over time, these rules help us anticipate how these atoms will interact. Like balls on a table their behaviours can be predicted. At both the tiny micro atomic level and the larger (macro level) of snooker balls, planets and people, science has successfully explained much of how our universe has developed and science can make predictions, allowing us to anticipate events and control our environments.

From *Georges Lemaître discovery that* our gigantic and expanding universe, was in fact forged in the fierce fires of the big bang to Laplaces' explanation for how our solar system formed from a cloud of swirling gases. From theories dedicated to explaining the inconceivably small interactions taking place at the strange quantum level, to theories explaining vast macro events, like the interactions of stars, planets and supernovas.

Theories have been developed that can explain how our universe brought forth first our world then, life forms, and eventually you, your, millions of cells your brain, and all of the aspects that make up our modern world. Science has

yielded exciting new technologies, like computers able to accurately model physical interactions, creating simulations like this one and calculating the complex probabilities necessary for modelling events at the quantum level. We can model the behaviour of cells and, to some extent, even the workings of the Human brain.

Scientists have had great success providing explanations for how our brains process information when encoding memories and making decisions. Perhaps the ultimate mystery still eludes scientists however. This mystery, known as the hard problem of consciousness, asks just how our capacity to consciously feel and experience came about. This may prove to be our universe's ultimate mystery. Research using brain scanners has mapped the networks activated during conscious experiences, the so-called neural correlates of consciousness.

but how atomic matter born in the fires of the big bang contributes to the conscious experiences that so fascinated the likes of Einstein, remains largely a mystery. In other words the thorny issue of just how and even if processing in our physical brain is sufficient, by itself to allow us to consciously experience, things like pain and love, this hard problem of consciousness, still remains the ultimate goal for many scientists.

The first step in answering the hard problem lies in deciding whether consciousness is solely the property of our physical brain or is produced elsewhere. Scientist Benjamin explored the role of the human brain in consciousness, his research findings have been replicated on multiple occasions and dozens of similar scientific studies have clearly established an important role for the human brain in generating our rich conscious experience of our world.

Research therefore suggests that consciousness is at least partially dependent on things happening in our physical brain. Conscious activity appears to be related to the activation of specific regions within the brain as well as the synchronous activity of networks of brain cells. This means that for us and the Einsteins of this world consciousness, draws upon brain processing. Processing that is now becoming researchable via new advanced brain scanners that can produce research charting the interactions and timings of these consciousness relevant brain networks. Other recent research now exploits the newest generation of brain stimulation devices to explore how inhibiting the brain's regions involved in consciousness, impacts experiences and behaviour.

many eminent scientists have contributed to our understanding of the universe. Thanks to them science is steadily unravelling the processes that turned atomic matter into planets capable of supporting life forms capable of

high-level intelligence. Yet only our remarkable gift for consciousness allows us to truly experience, on a profound personal level now it actually feels to truly live in the complex and amazing universe, that scientists investigate. Consciousness allows us to not only make art, like movies, but also to truly appreciate its beauty as far more than mere machines.

To conclude then, Scientists have long pondered human consciousness. Consciousness allows us to experience our universe in a remarkable way. Processing in the brain appears to contribute to this ability. Scientists are exploring consciousness, but we may never solve the hard problem of consciousness. Just how and indeed if, our universe brought forth our ability to consciously experience our world, solely from processes in the brain.