Consciousness and Cognition 22 (2013) 137–147

Contents lists available at SciVerse ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Beliefs in being unlucky and deficits in executive functioning

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ARTICLE INFO

Article history:
Received 18 February 2012
Available online 23 December 2012

Keywords:
Luck
Executive functioning
Shifting, Inhibition
Somatic Marker hypothesis

ABSTRACT

The current paper proposes the Dysexecutive Luck hypothesis; that beliefs in being unlucky are associated with deficits in executive functioning. Four studies suggest initial support for the Dysexecutive Luck hypothesis via four aspects of executive functioning. Study 1 established that self-reports of dysexecutive symptoms predicted unique variance in beliefs in being unlucky after controlling for a number of other variables previously reported to be related to beliefs around luck. Studies 2 to 4 demonstrated support for the Dysexecutive Luck hypothesis via assessment of executive functioning via: (1) two fundamental executive functions (shifting and inhibition), (2) emotional processes related to executive functioning as described by the Somatic Marker hypothesis, and (3) higher executive functions as accessed via divergent thinking. The findings suggest that individuals' beliefs in being unlucky are accompanied by a range of deficits in executive functioning.

1. Introduction

The role of luck in human decision-making and behaviour is considered across a number of domains, much more so than the normally cited superstition or gambling literature (e.g. Andre, 2009; Ellis, 1994). For instance, luck has been cited as playing a role in judgements in criminal law; for those practising law, the accused, the victim, and the juror. Luck may also be used when making judgements about endangerment statutes, presuming causation, and equating punishments (Kessler, 1994). In terms of the recent economic collapse of Western financial markets, the role of luck in influencing banking professionals to mistakenly perceive patterns in random financial data, and then misjudge possible outcomes, has been reported (Wall Street Journal, 2009). Among entrepreneurs, rating their own successes in business, luck is felt to be responsible for just less than 17% of performance (Loderer, Peyer, & Liechti, 2010). In terms of attributions of love, one's feelings towards one's own luck and their partner's luck is often considered as the causal factor to discovering one another (Ben-Zeév, 2009).

For a long time within the psychological literature, beliefs around luck were explained within irrational belief theory. Within this theory, beliefs around luck reflect absolute beliefs about the world, where many aspects of life are akin to chance, with luck having an external, unpredictive, and uncontrollable influence upon the individual, eventually forming the basis of emotional distress (Ellis, 1994). However, this view was reconsidered with the discovery that individual's beliefs in their own good luck can lead to positive outcomes (Darke & Freedman, 1997a, 1997b). Within this perspective luck is a personal attribute, that is also stable, predictable, and controllable, and has shown to be related to a number of positive outcomes such as better mental health and optimism (Darke & Freedman, 1997a, 1997b; Maltby, Day, Gill, Colley, & Wood, 2008). Moreover, Damisch, Stoberock, and Mussweiler (2010) examined the relationship between promoting lucky thoughts (via good luck

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http://dx.doi.org/10.1016/j.concog.2012.11.014

charms) and their subsequent positive effects, resulting in an increase in perceived self-efficacy, and performance in golfing, motor dexterity, memory, and anagram games.

Important to the current consideration is that the identification of belief in good luck has introduced a dynamic to how to improve psychological considerations of luck distinguishing between those who demonstrate beliefs in being lucky, beliefs in being unlucky, and those who do not believe in luck at all (Maltby et al., 2008). Furthermore, when considering theoretical and empirical explanations between beliefs in being unlucky and lucky, while there is growing evidence that beliefs in being lucky is accompanied by greater control and self-efficacy towards tasks (e.g. Darke & Freedman, 1997a, 1997b; Damisch et al., 2010), psychological accounts of those who have beliefs in being unlucky are less well developed (Maltby et al., 2008).

In this paper, we propose and test a supplementary viewpoint by which to consider beliefs in being unlucky. This proposition is based on the wider conceptualization that a range of cognitions, affect, and behaviours underpin the formation of attitudes and beliefs (Fabrigar, MacDonald, & Wegener, 2005), and that cognitive elements, and the evaluation and self-monitoring processes surrounding these cognitive elements, influence attitude and belief formation across a number of domains (Wegener & Carlston, 2005; Wyer & Albarracín, 2005). More specifically, we propose the Dysexecutive Luck hypothesis. With this proposition, we suggest that beliefs in being unlucky are associated with differential levels of executive functioning, a broad umbrella term used to capture a range of interacting high-level cognitive, emotional, and behavioural processes involved in goal or task-directed achievement. These basic processes include abilities around initiating, planning, devising alternate strategies around, organising, and paying attention to, tasks or goals.

The evidential basis for this approach begins with Wiseman (2004) who found, when comparing people who either described themselves as 'lucky' or 'unlucky', that 'unlucky' people failed to properly attend to potential rewards when they were presented, whereas 'lucky' people did. Wiseman suggested 'lucky' people may achieve certain goals, and 'unlucky' people may not achieve the same goals, simply because they approach these goals in a different manner. He suggests that 'lucky' people may have cognitive skills at creating and noticing opportunities, and by implication 'unlucky' people do not. Day and Maltby (2005) extended this view by showing how beliefs around luck were associated with goal achievement. Participants who believed themselves 'lucky' used luck as part of a cognitive schema comprising a need for hard work, adequate planning, and a need for luck to achieve outcomes (i.e. ''I should do well in a job interview if I prepare properly, but also if no-one better than me shows up''). They also found that those who believed themselves to be 'unlucky' did not develop such a schema and failed to achieve their goals.

The current paper suggests the Dysexecutive Luck hypothesis, by considering beliefs in being unlucky as being associated with deficits in executive functioning. There are two possible causal directions of an association between beliefs in being unlucky and deficits in executive functioning. Individual levels of executive functioning might be inadvertently influencing an individual's experience and reporting of 'being unlucky'. For example, if an individual shows a weakness in executive functioning abilities, and is unable to initiate, plan, devise alternate strategies, organise, and pay attention to task or goal-orientated behaviour, then they are less likely to achieve their goals and then they may consider themselves as 'unlucky'. Conversely, someone who believes themselves to be unlucky may not engage those executive functions needed to effectively initiate, plan, devise alternate strategies, organise, and pay attention in relation to task or goal-orientated behaviour, and therefore consequently fail at the goal. Notwithstanding the causational direction of the association between beliefs in being unlucky and deficits in executive functioning, the proposal is that the experience of being unlucky may reflect deficits in a series of executive functions needed to accomplish task or goals. The proposition that beliefs in being unlucky is positively associated with deficits in executive functioning is something that has not been examined directly within the current literature.[1]

1.1. Overview of studies

In this paper, we test for initial evidence for the veracity of the Dysexecutive Luck hypothesis; whether beliefs in being unlucky are accompanied by deficits in executive functioning. Four studies are presented to test this hypothesis, with each study exploring whether there is initial evidence for the Dysexecutive Luck hypothesis across a number of different established markers of executive functioning.

The first study sets out to establish whether there is a relationship between beliefs in being unlucky and a self-report of broad domains of dysexecutive symptoms covering a range of emotional, personality, motivational, behavioural, and cognitive problems (Wilson, Alderman, Burgess, Emslie, & Evans, 1996). Moreover, the study controls for a number of other variables related to beliefs in being unlucky, to establish whether there is any incremental value, at the self-report level, to proposing the Dysexecutive Luck hypothesis. Specifically, the study controls for a series of variables that have found to be associated with beliefs around luck; irrational beliefs (Maltby et al., 2008), optimism (Day & Maltby, 2005), self-efficacy (Damisch et al., 2010), and personality (Maltby et al., 2008). Therefore, finding evidence in this study for the Dysexecutive

[1] It is worth noting that we are not proposing an opposing position that individuals with beliefs in being lucky have improved executive functioning. Although evidence suggests that those who believe they are lucky may compare favourably to those who believe they are unlucky, these studies have rarely accounted for those who do not believe in luck. Therefore, the current evidence suggests that there is no reason to suggest that those who believe they are lucky have improved executive functioning than someone who does not believe in luck at all. Secondary evidence from our reported studies in this paper confirm this expectation as we found no relationship between beliefs in being lucky and any of the measures of executive functioning reported in this paper ($rs < .08$, $ps > .05$).

Luck hypothesis in terms of a statistically significant positive association between beliefs in being unlucky and dysexecutive symptoms would suggest the potential for the Dysexecutive Luck hypothesis to be considered alongside extant explanations of beliefs in luck.

The second study extends the consideration of the Dysexecutive Luck hypothesis beyond self-report data. To achieve this we use Miyake et al.'s (2000) taxonomy of executive functioning as an initial guide for considering possible executive functions. This model of executive functioning adopts an individual differences approach and suggests that executive functioning may be genetically heritable and relatively stable (Miyake et al., 2000; Friedman et al., 2008). Within Miyake et al.'s (2000) taxonomy there are three related, but distinct, latent components of executive functioning; Shifting (switching between tasks or mental sets), Updating (constant monitoring and the adding and removing of working memory contents), and Inhibition (suppression of dominant and prepotent responses).[2] In the second study, we explore the relationship between a belief in being unlucky and shifting (or 'task switching'; Monsell, 2003). Shifting concerns the executive functioning of shifting back and forth between multiple tasks, operations, or mental sets (Miyake et al., 2000; Monsell, 2003) and is an executive function important to cognitive models such as attentional control (Norman & Shallice, 1986). Therefore, finding evidence in this study for the Dysexecutive Luck hypothesis using measures of switch-cost would suggest the potential for the Dysexecutive Luck hypothesis to be considered within one of the three main fundamental executive functions described by Miyake et al. (2000). In accordance with the Dysexecutive Luck hypothesis, it is predicted that beliefs in being unlucky will share a statistically significant negative association with the ability to shift between tasks.

The third study seeks to consider experimental data for the Dysexecutive Luck hypothesis in two ways. The first was to extend the support found for the Dysexecutive Luck hypothesis in Study 2 by using another of Miyake et al.'s (2000) taxonomy of three main executive functions; namely inhibition of prepotent responses, or inhibition. The inhibition of prepotent responses is the ability to make a deliberate and controlled suppression of dominant, automatic, or influential responses when required (Miyake et al., 2000). The second way was to extend the current consideration is to consider executive functions that focus on emotion. The rationale for extending the consideration to emotion executive functions emerges from findings within the luck literature regarding luck, decision making (notably gambling), and the association with positive and negative emotions, such as positive affect (Jiang, Cho, & Adaval, 2009), or aggression (Siler, 2010). One core literature concerned with emotional aspects of executive functioning centers around the Somatic Marker hypothesis (Damasio, 1996, 1999). The Somatic Marker hypothesis outlines that, when complex, conflicting, and uncertain decisions are required, a net somatic state emerges from somatic markers created by pertinent stimuli, and that this somatic state influences implicit decision-making by simplifying the decision process in directing an individual's attention to advantageous options (Damasio, 1994, 1996, 1999). In accordance with the Dysexecutive Luck hypothesis, it is predicted that beliefs in being unlucky will share a statistically significant negative association with the ability to inhibit prepotent responses and to make decisions using somatic markers.

The fourth study considers whether there is initial evidence for the Dysexecutive Luck hypothesis in terms of higher-level executive functioning. Divergent, or creative, thinking abilities demonstrate reliance on higher levels of executive functioning (e.g. abstract thinking, problem solving, cognitive flexibility, formation, and mental fluency) with key higher executive functioning aspects such as attention, language, and perception, combining to generate divergent thinking (Delis et al., 2007). Therefore, finding evidence in this study for the Dysexecutive Luck hypothesis would suggest the potential for the Dysexecutive Luck hypothesis to be considered within higher levels of executive functioning. In accordance with the Dysexecutive Luck hypothesis, it is predicted that beliefs in being unlucky will share a statistically significant negative association with divergent thinking.

2. Study 1

The aim of the first study is to examine whether there is an association between beliefs in being unlucky and a broad domain of dysexecutive symptoms, after controlling for a range of existing psychological explanations of beliefs around luck (e.g. irrational beliefs, self-efficacy, optimism, and personality).

2.1. Method

2.1.1. Sample

One hundred and fifty-four respondents (73 males and 81 females) were obtained from a series of community groups and workplaces in the Midlands and South Yorkshire region of the United Kingdom. Ages ranged from 21 to 58 years (M = 32.49 years, SD = 6.63). Participants were predominantly White (41.6%), with 27.9% of the respondents reporting to

[2] In this paper, we limited the testing of the Dysexecutive Luck hypothesis to only two of the main executive functions described within Miyake et al.'s taxonomy; shifting (Study 2) and inhibition (Study 3). Miyake et al. describe updating as more than the simple maintenance of working memory representations, rather the ability to change existing and irrelevant information in working memory by monitoring and coding newer and relevant information. Furthermore, updating is thought to reflect temporal abilities and may be dependent on working memory capacity (Jonides & Smith, 1997; Lehto, 1996; Morris & Jones, 1990). However, shifting and inhibition are described as relatively simpler working memory maintenance or processes that involve either stopping responses (inhibition) or controlling attention (shifting). Therefore, these two processes seemed the most suitable starting points for testing the Dysexecutive Luck hypothesis.

be Asian, and 24.0% reporting to be Black. Just under half of the respondents (49.7%) reported to be married (or living together as being married), and 37.7% of the respondents reporting to be single. Just over forty percent (40.3%) of the respondents reported having at least an 'A' Level qualification or equivalent, with 35.2% of the respondents reported to have an 'O' level/GCSE qualification or equivalent. Recruitment of participants was opportunistic with advertisements displayed, after seeking relevant permissions, via fliers in over 30 local workplaces, community groups, and colleges with originally 450 questionnaires being distributed. Respondents did not receive any payment for their involvement in the study. In advertising the study, no specific mention was made regarding the study being about luck with the fliers describing that the study would be concerned with attitudes and beliefs.

2.1.2. Measures

Respondents completed the following measures:

The 6-item beliefs in being unlucky subscale from *Darke and Freedman's Beliefs around Luck scale* (Darke & Freedman, 1997a; Maltby et al., 2008) which comprises a rewording of Darke and Freedman's original Beliefs in Good Luck scale to measure beliefs in being unlucky (e.g."I consider myself to be an unlucky person"). Responses are scored on a 5-point scale (1 = *Strongly Disagree* to 5 = *Strongly Agree*), with higher scores indicating a greater degree of belief in being unlucky. Internal reliability estimates for this scale range from $\alpha = .85$ to .88 and test–retest reliability estimates range from .52 to .80 for 2 and 4 week time periods (Maltby et al., 2008). Scores on the scale also show validity by acceptable correlations between both peer and family ratings and other established measures of the individual's beliefs around luck (Maltby et al., 2008).

The Dysexecutive Questionnaire (DEX; Wilson et al., 1996) is a 20-item standardized self-report assessment of executive functioning originally designed to measure the severity of dysexecutive symptoms shown by patients with frontal lobe damage. Items refer to self-reports of behavioural difficulties commonly associated with dysexecutive syndrome across four categories: (a) emotional or personality problems (e.g. "I have difficulty showing emotion" [item 11]), (b) motivational problems (e.g. "I find it difficult to keep my mind on something and am easily distracted" [item 18]), (c) behavioural problems (e.g. "I do or say embarrassing things when in company of ethers" [item 9]), and (d) cognitive problems (e.g. '"I have difficulty thinking ahead or planning for the future" [item 4]). Responses are scored using a 5-point scale (0 = *Never* to 4 = *Very Often*), with responses computed to a total score, and higher scores indicating a greater degree of deficits in executive functioning. The self-report scale demonstrates validity as a measure of behavioural symptoms representing types of deficits in executive functioning, for example, its relationship with other measures of executive function (Burgess, Alderman, Evans, Emslie, & Wilson, 1998), and that the cognitively less fit elderly reported substantially more deficits in executive functioning on the DEX than cognitively fit elderly (Gerstorf, Siedlecki, Tucker-Drob, & Salthouse, 2008).

The 10-item *Life Orientation Test – Revised* (LOT-R; Scheier, Carver, & Bridges, 1994) was used to assess an individual's level of dispositional optimism. Six of the items are used to measure optimism (e.g. "I'm always optimistic about my future"), with four of the items used as filler items. Responses are scored on a 5-point scale (1 = *Strongly Disagree* to 5 = *Strongly Agree*), with higher scores indicating a greater degree of dispositional optimism. The LOT-R has shown adequate reliability estimates of above .70 and show test-rest stability of between $r = .60$ and .79 over times periods ranging from 4 weeks to a year (Scheier et al., 1994).

New General Self-Efficacy Scale (Chen, Gully, & Eden, 2001) is an 8-item measure that assesses self-efficacy as a belief in overall competence to attain the required performance across a variety of achievement situations (Eden, 2001). Example items include "In general, I think that I can obtain outcomes that are important to me" and "Even when things are tough, I can perform quite well". Responses are scored using a 5-point scale (1 = *Strongly Disagree* to 5 = *Strongly Agree*), with higher scores indicating a greater degree of generalised self-efficacy. Internal reliability estimates for these two scales range from .85 to .90, with evidence suggesting a one-dimensional structure to the scale (Chen et al., 2001).

The 11-item *Irrational Beliefs Scale* (Watson et al., 1990), derived from a previously well-used measure of irrational beliefs (MacDonald & Games, 1972), but uses simplified language to measure irrational beliefs. Examples of the scale's items include "I feel it is a catastrophe when things are not the way I would very much like them to be" and "I am often upset over other people's problems". Responses to items on the Irrational Beliefs scale are scored on a 5-point response format (1 = *Strongly Disagree* to 5 = *Strongly Agree*), with higher scores on the scale indicating a higher degree of irrational beliefs. Although reports on this measure of irrational beliefs are limited, available evidence suggests that the scale represents one factor among nonclinical samples (Mahoney, 1997; Maltby & Day, 2001).

Ten-Item Personality Inventory (TIPI; Gosling, Rentfrow, & Swann, 2003) is a 10-item measure of the five-factor model of extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience. The inventory contains ten pairs of two trait descriptors that aim to establish a broad coverage of traits whilst trying to avoid a redundancy of using a number of items. Participants rate on a 7-point scale (1 = *Strongly Disagree* to 7 = *Strongly Agree*). Overall scores are computed by dividing the total score for each pair of item by 2 with higher scores on the scale indicating higher degree of each of the five factor personality dimensions. The authors report adequate test–retest reliability and adequate levels of convergent and discriminant validity and relationships with external correlates, noting that the TIPI scales have only two items that result in low internal consistency estimates (Gosling et al., 2003).

2.2. Results and brief discussion

No sex differences occurred between any of the scales, with the exception of neuroticism where females ($M = 7.74$, $SD = 3.07$) were found to score significantly higher, $t(152) = -2.88$, $p = .005$, than males ($M = 6.37$, $SD = 2.82$). Further, no significant correlations were found between age and any of the scales, with the largest correlation being between age and openness to experience ($r = -.12$, $p = .098$). Table 1 shows the mean scores for all the variables, alpha coefficients for all of the multi-item scales, all above an acceptable internal reliability criteria of $\alpha = .70$ (Kline, 1986), and zero order correlations between all the measures.

Beliefs in being unlucky share a significant positive association with dysexecutive symptoms, irrational beliefs, neuroticism, and a significant negative association with general self-efficacy, optimism, extraversion, agreeableness, and openness to experience. In terms of effect size, the zero order correlation between beliefs in being unlucky and dysexecutive symptoms ($r = .45$) suggests this association is of a large effect size if one uses one conventional standard for interpreting correlation-based effect sizes as small ($r = .10$–$.23$), medium ($r = .24$–$.36$), and large ($r = .37$ or higher) (Cohen, 1992). Though the association is of a median effect size if one applies the other conventional criteria of $r = .3$ and above as a medium effect size and $r = .5$ or above as a large effect size (Cohen, 1988, 1992).

A 2-step hierarchical multiple regression was performed to examine whether dysexecutive symptoms could predict beliefs in being unlucky, after controlling for extant theories of luck. Variance Inflation Factors (VIF) and tolerance factors for the predictor variables were no larger than 1.80 and no smaller than 0.56 respectively. Therefore, these statistics do not contravene threshold values of VIF of 10 or at least 5 and tolerance statistic of less than .20 or .10 that are used as rationale to suggest collinearity between the independent variables (Kutner, Nachtsheim, Neter, & Li, 2004).

The findings from the regression model are presented in Table 2, with unstandardized and standardized regression coefficients, t values, and probability statistics presented for each predictor variable. In the first step, the inclusion of all of the variables (with the exception of dysexecutive symptoms) in predicting beliefs in being unlucky reached statistical significance ($R = .68$, $R^2 = .46$, Adjusted $R^2 = .43$, $F_{8,145} = 15.39$, $p < .001$), with self-efficacy, optimism, and neuroticism demonstrating statistical significant regression coefficients. In the second step, the inclusion of dysexecutive symptoms was found to provide a significant R^2 change (R^2 change = .027, F change$_{1,\ 144} = 7.66$, $p = .006$) with dysexecutive symptoms demonstrating a statistical significant regression coefficient (see Table 2).

The current findings suggest some probity in our original hypothesis that beliefs in being unlucky are related to deficits in executive functioning. Specifically, beliefs in being unlucky were predicted by higher levels of dysexecutive symptoms, after controlling for irrational beliefs, self-efficacy, optimism, and personality (notably neuroticism).

3. Study 2

The aim of Study 2 was to establish whether there was a relationship between beliefs in being unlucky and the executive function of shifting.

3.1. Method

3.1.1. Sample

Fifty undergraduates (6 males and 42 females) aged 18 to 24 years ($M = 19.32$ years, $SD = 1.7$) from a United Kingdom university took part in the study. Respondents were volunteers from a pool of participants from a university experiment participation scheme where students take part in experiments in return for being able to recruit participants to their own projects. Studies were advertised and volunteers signed up via an electronic diary system. As with Study 1, no explicit mention was made regarding the study being concerned with beliefs around luck, rather the study just made mention to general

Table 1
Mean scores, alpha coefficients for, and Zero order correlations between, all the measures (Study 1).

	M	SD	α	1	2	3	4	5	6	7	8	9	10
1. Beliefs in being unlucky	14.13	6.25	.95	–	.45**	.45**	−.55**	−.30**	.49**	−.26**	−.22**	−.16	−.34**
2. Dysexecutive symptoms	28.80	12.97	.90		–	.43**	−.38**	−.15	.42**	−.16*	−.36**	−.49**	−.29**
3. Irrational beliefs	25.39	8.15	.82			–	−.52**	−.16*	.43**	−.43**	−.21**	−.28**	−.41**
4. General self-efficacy	29.60	4.56	.88				–	−.02	−.46**	.34**	.14	.27**	.28**
5. Optimism	17.65	2.34	.87					–	−.17*	.08	.21*	.06	.19*
6. Neuroticism	3.55	1.51	N/A						–	−.29**	−.33**	−.18*	−.26**
7. Extraversion	4.75	1.39	N/A							–	.19*	.04	.48**
8. Agreeableness	5.22	1.18	N/A								–	.11	.20*
9. Conscientiousness	4.61	1.40	N/A									–	.17*
10. Openness	5.16	1.07	N/A										–

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

Table 2
Two step Hierarchical Multiple Regression with beliefs in being unlucky is a dependent variable, and sex, age, irrational belief, self-efficacy, optimism, and five factor model of personality used as predictor variables, with dysexecutive symptoms introduced in Step 2 (Study 1).

	B	*β*	*t*	*p*
Step 1				
Irrational beliefs	.07	.09	1.09	.278
General self-efficacy	−.55	−.40	−5.16	.001
Optimism	−.64	−.24	−3.74	.001
Neuroticism	.45	.22	2.95	.004
Extraversion	.14	.06	.81	.422
Agreeableness	−.03	−.01	−.20	.846
Conscientiousness	.11	.05	.73	.464
Openness	−.36	−.12	−1.68	.095
Step 2				
Irrational beliefs	.04	.05	.66	.511
General self-efficacy	−.52	−.38	−4.96	.000
Optimism	−.62	−.23	−3.72	.000
Neuroticism	.38	.18	2.46	.015
Extraversion	.09	.04	.57	.568
Agreeableness	.09	.03	.49	.622
Conscientiousness	.28	.13	1.81	.072
Openness	−.31	−.11	−1.47	.144
Dysexecutive symptoms	.11	.22	2.77	.006

beliefs. The number of participants recruited to the study was based on a quota allowed to the experimenter under the experiment participation scheme. No respondents failed to complete or withdrew from the experiment.

3.1.2. Measures

All respondents completed the beliefs in being unlucky subscale from the *Darke and Freedman's Beliefs around Luck scale* (Darke & Freedman, 1997a; Maltby et al., 2008 [described in Study 1]).

To measure shifting we employed a task-switching experiment based on the number–letter task experimental paradigm suggested by Rodgers and Monsell (1995) and which measures shifting (Miyake et al., 2000). In this computer experiment, respondents were presented with a series of three conditions: the first two conditions completing relatively simple tasks, and the third condition involving switching to a more complicated task. The first condition comprised 30 trials, and each trial involved the presentation of a stimulus composed of a pair of characters presented side by side. In this task only one of the two characters was a letter, with the other character being a symbol (e.g. &, ∗). The letter was presented randomly either left or right of the pair and the characters were closely adjacent. The participants classified a letter as a consonant or vowel with the aid of a button press. Participants then moved onto a second condition, comprising 30 trials, in which pairs of characters were presented side by side. On this occasion, the target character was a digit, and the other character a symbol. As with the first task, the letter was presented to either the left or right of the pair and the characters were closely adjacent. Respondents had to classify the number as odd or even via a button press. The third condition represented a switch to the more complicated task. The task-switch condition (also 30 trials) comprised a stimulus that was made up of letter and digit character pairs with the order of the presentation of the letter and digit being randomised. Here participants were asked to focus on both the letter and the digit and to select, via a button press, in order from left to right, whether the character pair contained a vowel or consonant, and then if the character digit was odd or even. The length of each presentation was 5000 ms, the stimulus remained on the screen until the participant pressed a key or until 5000 ms had elapsed, with a 150 ms interval before the next stimulus was presented. The accuracy and reaction time of responses were recorded via the computer program.

3.2. Results

A repeated measures ANOVA found a statistical significant difference for number of correct answers ($F[2, 48] = 387.66$, $p < .001$, $\eta_p^2 = .88$) and mean reaction time for correct answers (RT) ($F[2, 48] = 31.47$, $p < .001$, $\eta_p^2 = .39$) across the conditions. For correct answers, within-subject comparisons for conditions, using a Bonferroni correction, found that correct answers for the first simple task ($M = 29.02$, $SD = 1.06$) and second simple task ($M = 29.18$, $SD = 1.05$) were statistically significantly higher ($p < .001$ for both) than correct answers for the complicated task ($M = 16.12$, $SD = 4.42$). Further, within-subject comparisons for conditions, using a Bonferroni correction, found the reaction time (RT) for the complicated task ($M = 731.34$ ms, $SD = 183.62$) was significantly higher ($p = .007$, $p < .001$ respectively) than the first simple task ($M = 664.56$ ms, $SD = 133.88$) and the second simple task ($M = 564.02$ ms, $SD = 78.91$). The decrease in correct answers and the increase in RT between the second simple task to the more difficult task suggests we observed a switch-cost in the current sample.

In terms of beliefs in being unlucky and switch-cost, a hierarchical multiple regression analysis examined the extent to which switch cost predicted beliefs in being unlucky after controlling for a number of factors. Variance Inflation Factors (VIF)

and tolerance factors for the predictor variables were no larger than 2.12 and no smaller than 0.47 respectively, therefore not contravening the aforementioned threshold values to suggest collinearity between the independent variables. Table 3 shows the unstandardized regression coefficient (*B*), standardized regression coefficients (β), *t*-test scores, and probability variables for each predictor variable in the regression.

For beliefs in being unlucky, number of correct answers for each of the conditions, and the RT for correct answers for the two simple conditions were the first to be entered into the regression equation. Together these were not able to predict scores on the measure of beliefs in being unlucky ($R = .29$, $R^2 = .09$, Adjusted $R^2 = .02$, $F_{5,44} = .85$, $p = .55$). Next the RT for correct answers for the complicated task condition was entered into the equation and was found to provide a significant R^2 change (R^2 change = .13, F change$_{1, 43} = 6.96$, $p = .012$) with the mean RT for correct answers to the complicated task condition demonstrating a statistical significant regression coefficient (see Table 3).

4. Study 3

The aim of Study 3 was to establish whether there was a relationship between beliefs in being unlucky and (1) the executive function of inhibition of prepotent responses and (2) an emotional executive function as indicated by the Somatic Marker hypothesis.

4.1. Method

4.1.1. Sample

Sixty students (30 males and 30 females) from a United Kingdom university took part in the study. Ages ranged from 18 to 30 years ($M = 20.38$ years, $SD = 2.29$). Participants were predominantly White (70.0%), with 13.3% of respondents reporting to be Asian, and 16.7% reporting to be Black. Respondents were volunteers from a pool of participants from an university experiment participation and advertising scheme described in Study 2. As with previous studies no explicit mention was made regarding the study being concerned with beliefs around luck, rather the study just made mention to general beliefs. The number of participants recruited to the study was based on a quota allowed to the experimenter, with an additional specific criterion on this occasion to recruit similar numbers of males and females. Though from the same university, none of the respondents in this study took part in Study 2, and the two studies took place 15 months apart. No respondents failed to complete or withdrew from the experiment.

4.1.2. Measures

Respondents completed the following measures as described in Study 1; beliefs in being unlucky subscale of the Darke and Freedman's Beliefs around Luck scale (Darke & Freedman, 1997a; Maltby et al., 2008), and the Dysexecutive Questionnaire (Wilson et al., 1996). The Dysexecutive Questionnaire was included to examine to what extent self-report aspects of executive functioning collated with the experimental measures included in this study.

In addition, respondents completed two experimental measures: The Stroop Test (Stroop, 1935), and the IOWA Gambling Task (Bechara, Damásio, Damásio, & Anderson, 1994). The Stroop Test has been described as a prototypical Inhibition task (Miyake et al., 2000) and evidence for the Somatic Marker hypothesis has been largely based on findings using the IWOA Gambling Task (Bechara, Damasio, Tranel, & Damasio, 2005).

The Stroop Test was presented via a computer program. Three conditions are presented in three separate blocks: (1) a trial with neutral stimuli with a letter string composed of X's presented in four colours (red, green, blue, and yellow), (2) a trial comprised of congruous stimuli in which the name of the colour was the same as the colour in which the letters are printed in, and (3) a trial comprised of incongruous stimuli in which the word 'red', 'green', 'blue', or 'yellow' was printed in a colour

Table 3
Regression analysis with beliefs in being unlucky used as a dependent variable, and correct answers to each condition, mean reaction time to other conditions in the experiment (Step 1) and mean reaction time to complicated task (Step 2) used as predictor variables (Study 2).

	B	*β*	*t*	*p*
Step 1				
Correct answers to first simple task	.83	.15	1.02	.315
Correct answers to second simple task	.15	.03	.18	.858
Correct answers to complicated task	−.25	−.19	−1.30	.200
Mean reaction time to first simple task	.01	.19	.96	.344
Mean reaction time to second simple task	−.01	−.17	−.89	.381
Step 2				
Correct answers to first simple task	.45	.08	.57	.571
Correct answers to second simple task	.22	.04	.28	.782
Correct answers to complicated task	−.10	−.08	−.54	.592
Mean reaction time to first simple task	.01	.03	.16	.877
Mean reaction time to second simple task	−.02	−.22	−1.18	.244
Mean reaction time to complicated task	.01	.43	2.64	.012

different from the named colour. Respondents were asked to identify the colour manually with the use of the same keys on the keyboard, which were marked on the computer. Participants were presented with seven blocks, each comprising 36 trials. Participants started with a trial block, using the name of the colour that the letters were printed in. The respondents then completed each of the six blocks, with no block presented twice in a row. Each stimulus remained on-screen for no longer than 12 s, and each stimulus followed a delay of 1500 ms. The accuracy and time of responses were recorded within the programme, with mean reaction times for accurate answers computed for each condition.

The IOWA Gambling Task (IGT; Bechara et al., 1994), also administered via a computer program, involves the participant choosing cards from four decks (A, B, C, and D) for a total of 100 trials (five blocks of 20 choices each). Each deck has a fixed and pre-programmed system of rewards and punishments. Decks A and B produce large rewards, however the penalties are higher, making these decks disadvantageous. Decks C and D contain smaller rewards, but the overall penalties are far less thereby ultimately producing the greatest amount of money. Typically, participants should select cards from the disadvantageous decks, but over the 100 trials should learn to play from the advantageous decks that produce lower penalties. Therefore, the IOWA Gambling Task allows for scoring of an individual's decision-making and learning behaviour in terms of adaptive or impaired skills. The presentation order of the Stroop Test and IGT was counterbalanced, with the administration of the questionnaires being administered either before or after the tasks.

4.2. Results

For the Stroop Test, comparison of the mean RT scores provides a general overview of the main effects within these experiments. In terms of the Stroop Test, a repeated measures ANOVA found a statistical significant difference for the mean RT across the three conditions, $F(1, 59) = 120.75$, $p < .001$, $\eta_p^2 = .67$. Within-subject comparisons for conditions, using a Bonferroni correction, reported that the RT for the neutral stimuli ($M = 689.30$ ms, $SD = 64.40$) was statistically significantly higher ($p < .001$) than the RT for congruent stimuli ($M = 659.04$ ms, $SD = 42.45$). The RT for the incongruent stimuli ($M = 777.21$ ms, $SD = 75.29$) was statistically significantly higher than the RT for both the neutral, and therefore also the congruent material (both $p < .001$). The pattern of these means is consistent with the model of expected differences between RT to these different stimuli. The first is the identification of *semantic interference*, the RT to the neutral stimuli is faster than in incongruent conditions. The second is the identification of *semantic facilitation*, the RT to the congruent stimuli is faster than in the neutral condition (van Maanen, van Rijn, & Borst, 2009). Most importantly, the significant difference between the incongruent and congruent stimuli suggests that we observed a Stroop effect among the current sample. The magnitude of the Stroop effect among each participant was computed by subtracting the mean RT to congruous stimuli from mean RT to incongruous stimuli, with higher RTs representing higher levels of poorer executive functioning in response to task interference.

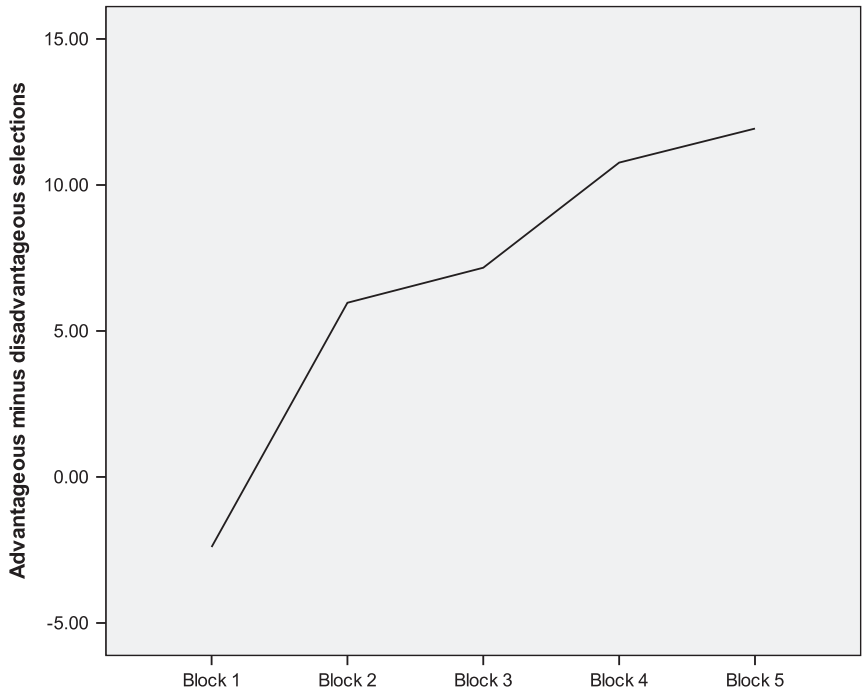

Fig. 1. Means of the total number of advantageous minus disadvantageous cards in each block of 20 cards (Study 3).

For the IGT, to show the effect of learning, consistent with Bechara et al. (1994), we subdivided the 100 trials into five blocks consisting of 20 trials in the order they were undertaken. A single score was calculated for each participant using the formula *(C + D) 'good decks' – (A + B) 'bad decks'* for each block, and consistent with previous reports, the means scores for each block are plotted to show a general learning curve demonstrating individuals' general learning to play from the advantageous decks (see Fig. 1). Consequently, we summed the scores for the five blocks to produce a single score of non-impaired performance on the IGT.

Table 4 shows the Pearson product-moment correlation coefficients between the Stroop effect, individual's non-impaired performance on the IGT, beliefs in being unlucky, and dysexecutive symptoms. The two experimental indicators of executive functioning share a significant negative relationship with each other, and each a significant association with dysexecutive symptoms in the expected direction, suggesting that all measures are reflecting aspects of executive functioning. Beliefs in being unlucky share a significant positive association with longer RT responses to task interference (Stroop effect), a significant negative association with non-impaired decision-making (IGT), and a significant positive association with higher levels of dysexcutive symptoms. In terms of effect size, using the two conventional criteria outlined in Study 1, the association between beliefs in being unlucky and the two measures of executive functioning in this study are of a median effect size.

5. Study 4

The aim of Study 4 was to establish whether there was a relationship between beliefs in being unlucky and a measure of divergent thinking.

5.1. Method

5.1.1. Sample

Seventy participants (31 males and 39 females), aged between 19 and 63 ($M = 33.73$, $SD = 12.39$) were sampled from 17 large workplaces ($n > 50$) in two city populations in the UK. Among the current sample, 61.4% of the respondents were White, 18.6% were Black, and 12.9% were Asian. An initial criterion for inclusion in the study was that the individuals reported that as part of their job role they had to; (1) solve problems and (2) be creative. Those who did not fulfil these criteria took part in another study not reported in this paper. In advertising the study, no specific mention was made regarding the study being about luck with the study described as concerned with attitudes and beliefs. Respondents were recruited until a quota of 70 was reached. None of the participants in this study took part in Study 1. No respondents failed to complete, or withdrew, from the experiment.

5.1.2. Measures

All respondents completed the beliefs in being unlucky subscale of the Darke and Freedman's Beliefs around Luck scale (Darke & Freedman, 1997a; Maltby et al., 2008) and the Dysexecutive Questionnaire (Wilson et al., 1996). Both scales are described in Study 1. As with Study 1, the Dysexecutive Questionnaire was included to examine to what extent self-report aspects of executive functioning collated with the experimental measure included in this study.

All participants also completed Guilford's (1967) unusual uses for inanimate objects as measure of divergent thinking. For this study, we used three of the five objects suggested by Hudson (1967): a brick, a blanket, and a paperclip (with a tin of boot polish and a barrel omitted because they were considered out of date terms). Participants were asked to list as many unusual uses for each of the objects, each for five minutes, and divergent thinking was scored by a frequency count of unusual uses that were agreed by two of the experimenters. The administration of the questionnaires were counterbalanced either side of the task.

5.2. Results

Cronbach's alpha coefficients for the belief in being unlucky subscale ($\alpha = .88$), dysexecutive symptoms ($\alpha = .92$), and the three items on the divergent thinking task ($\alpha = .85$) were all-satisfactory and above the well-used criteria of $\alpha = .70$.

Table 4
Zero order correlations between all the measures (Study 3).

	1	2	3	4
1. Stroop Effect	–	−.378**	.358**	.410**
2. Non impaired performance (IGT)		–	−.415**	−.498**
3. Beliefs in being unlucky			–	.469**
4. Dysexecutive functions				–

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

Significant Pearson product-moment correlation coefficients were found between divergent thinking and beliefs in being unlucky ($r = -.39$, $p = .001$), divergent thinking and dysexecutive symptoms ($r = -.53$, $p < .001$), and beliefs in being unlucky and dysexecutive symptoms ($r = .40$, $p < .001$). In terms of effect size, using the two conventional criteria outlined in Study 1, the association between beliefs in being unlucky and divergent thinking in this study is of a median to large effect size, depending on the convention used.

6. Discussion

The current studies show support for the Dysexecutive Luck hypothesis; that beliefs in being unlucky are associated with deficits in executive functioning. Specifically, beliefs in being unlucky are related to deficits in executive functioning across a number of domains; a self-report measure of dysexecutive symptoms, shifting between tasks, inhibition of prepotent responses, ability to make decisions using somatic markers, and higher executive functioning. Therefore the current findings suggest that those who believe themselves to be unlucky, and their experience of being unlucky, may, to an extent, reflect deficits in a series of executive functions needed to initiate, plan, develop strategies around, organise, and pay attention to task or goal-orientated behaviours.

One key finding from Study 1 is that the association between beliefs in being unlucky and dysexecutive symptoms is incremental to other theories of beliefs around luck (albeit the zero order correlations are smaller or equal to the reported associations with self-efficacy, neuroticism, and irrational beliefs). Therefore, the finding is of additional interest to other well-established theories of beliefs around luck. Moreover, there are a number of significant correlations between dysexecutive symptoms and irrational beliefs, self-efficacy, and the five factor model of personality. Therefore, it would be useful to consider how the Dysexecutive Luck hypothesis might be usefully integrated or complimented with the theories surrounding irrational beliefs, self-efficacy, and the five factor model of personality to further explain and explore findings emerging from the Dysexecutive Luck hypothesis. One key aspect missing from the current consideration is the possible relationship between the beliefs in being unlucky and one aspect of Miyake et al.'s (2000) taxonomy; updating and monitoring of working memory representations. Therefore, this may be a focus for future research.

Another key aspect not addressed by the current studies is the causation direction of the relationship between beliefs in being unlucky and deficits in executive functioning. This may be of interest to further researchers. As hypothesised, it is likely that causation can occur in both directions: (1) poor executive functioning might be inadvertently influencing an individual's experience and reporting of being unlucky, and (2) someone who believes themselves to be unlucky may be underperforming when it comes to outcomes of executive functioning. However, current findings, particularly from the findings from Studies 2 and 3, do suggest avenues that may suggest support for one of the causation directions. Switch cost tasks, Stroop Tests, and IWOA Gambling Tasks are all well-established proxies for physiological functioning. For example, task-switching activates the neural system (Wager, Reading, & Jonides, 2004), the Stroop test has found to be related to activation in the frontal lobe, (Spreen, Strauss, & Sherman, 2006), and the IGT has been shown, via FMRI studies, to be related to aspects of the prefrontal cortex (Li, Lu, D'Argembeau, Ng, & Bechara, 2010). Therefore, looking at direct assessment of physiological functioning and beliefs in being unlucky would investigate to what extent executive functioning is an antecedent to beliefs in being unlucky. Moreover, much like experimental designs using stereotype threat (Steele & Aronson, 1995), priming for beliefs in being unlucky, for example suggesting performance on an executive functioning task is based on luck, may reveal how beliefs in being unlucky may influence performance on executive functioning measures.

These findings may have important applications where beliefs around being unlucky may be found to influence decisions and decision making, such as, in opportunities for entrepreneurship in business, or opportunities in education, or work may be missed because of individual's perceived own bad luck. Our current findings suggest that whatever the causation direction of the association, individuals who self-report being unlucky also self-report deficits in executive functioning. Therefore, there is evidence that they may be potentially aware, or could be made aware, of this association. Our findings could provide a context for considering this information when developing interventions focused on developing skills among individuals that seek to reduce 'unlucky' barriers to success. For instance in therapeutic settings, when practitioners are working with people who believe luck works against them achieving their goals, they might consider how encouraging a better set of cognitions and skills around executive functioning (e.g. divergent thinking, learning strategies, and how to deal with changes in environmental demands) will help the individual achieve their goals.

In summary, the current findings suggest initial empirical support for the innovative proposition, termed the Dysexecutive Luck hypothesis, by findings that beliefs in being lucky are associated with deficits in executive functioning across a series of self-report and experimental measures of executive functioning.

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