DISTRACTION, NOT HUNGER, IS ASSOCIATED WITH LOWER MOOD AND LOWER PERCEIVED WORK PERFORMANCE ON FAST COMPARED TO NON-FAST DAYS DURING INTERMITTENT FASTING

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ABSTRACT

Using a repeated measures design, sixteen females recorded hunger, distraction, mood and perceived work performance on two consecutive fast days, two earlier and two subsequent consecutive non-fast days, during intermittent fasting. Using regression analyses, low positive mood was associated with higher distraction (β=-0.38, $p<0.01$), and lower perceived work performance was associated with higher distraction (β=-0.50, $p<0.01$), and lower positive mood (β=0.59, $p=0.01$). No associations were found with hunger (largest β -0.11, $p=0.15$). Associations between mood, perceived work performance and distraction but not hunger, mirror those found in traditional dieting, and suggest no benefit for attention from intermittent fasting-type regimes.

INTRODUCTION

Impacts of food restriction on mood and performance are well known. Dieting and fasting have been found to result in poor mood; increased anxiety, nervousness, irritability, anger, frustration, depression, emotionality, negative emotionality and negative hyperemotionality; poor concentration, poor vigilance, slower reaction times, slower decision making, and poorer memory (see Benton & Parker, 1998; Green, Elliman & Rogers, 1997; Green & Rogers, 1995; Hagan, Tomaka & Moss, 2000; Keys, Brozek, Henschel, Mickelsen & Taylor, 1950; Laessle, Platte, Schweiger & Pirke, 1996; McFarlane, Polivy & McCabe, 1999; Sunram-Lea, Owen, Finnegan & Hu, 2011).

Mechanisms behind these effects, however, remain unclear. Food restriction can clearly impact on energy intake and thus may impact on energy availability, and more specifically, glucose availability. Low blood and brain glucose levels have been linked to low mood (Benton, 2002; Benton & Nabb, 2004; Benton, Slater & Donohoe 2001, Gonder-Frederick, Cox, Bobbitt & Pennabaker, 1989), and poor cognitive performance, including slow reaction times, poor executive functioning, poor decision making, poor memory recall and low levels of performance and productivity (Benton & Parker, 1998; Sunram-Lea, Foster, Durlach & Perez, 2001; Sunram-Lea, et al, 2011; Owen, et al, 2012).

Repeated evidence, however, also suggests that, not only does the physiological deprivation in dieting impact on mood and performance, but that the psychological requirements for food restriction can also impact on mood and performance (Appleton & McGowan, 2006, McFarlane et al, 1999; Polivy, 1998). Traditional forms of dieting typically require careful calorie monitoring, and so require individuals to pay a lot of attention to food and eating (Collier, 2013). This required attention has been suggested to result in reduced cognitive resources available for other tasks, such as decision making and work performance (Green & Rogers, 1995; Green et al, 1997; Jones & Rogers, 2003), and many authors now argue that

effects of dieting on mood and performance likely result entirely from this increased cognitive load (Green et al, 1997; Green & Rogers, 1995; Jones & Rogers, 2003; Shaw & Tiggeman, 2004; Tiggeman, 2000).

Certain forms of food restriction, however, require less attention than others. Intermittent fasting involves fasting or consumption of up to only 500/600 kcal. per day on specific days interspersed with days on which participants can consume as much as they wish (Mosley & Spencer, 2013). Importantly, this dietary pattern requires much less attention to food than traditional dieting – individuals only monitor their food intake on certain days / at certain times, and at these times typically either consume nothing or consume only one small meal (Collier, 2013; Mosley & Spencer, 2013). Individuals are not constantly faced with difficult decisions about food and eating, but instead have clear and definitive all-or-nothing type rules (Collier, 2013). Dieting or fasting for intermittent days compared to longer has thus been suggested to have fewer effects on mood and performance than more consistent traditional dieting (Mosley & Spencer, 2013), not only because the time period for energy restriction is less, but also because the psychological deprivation and hardship seems much less (e.g. Polivy, 1998; Laessle, et al, 1996). Diets involving intermittent fasting have also been associated with improved weight loss, and improved risk profiles for many major health conditions, including CVD, cancer and diabetes (Heilbronn, Smith, Martin, Anton & Ravussin, 2005; Varady & Hellerstein, 2007), and are becoming increasingly popular with professionals and users alike (Collier, 2013).

Reduced distraction compared to traditional diets could further enhance the benefits of intermittent fasting. This study aimed to investigate the impact of fasting on perceptions of hunger, distraction, mood, and perceived work performance, and the degree to which the effects on mood and performance were accounted for by perceptions of hunger and distraction.

METHODS

The study was conducted using a repeated measures design. Hunger, distraction, mood and perceived work performance were recorded on two consecutive fast days, during an intermittent fasting regime, and compared to hunger, distraction, mood and work performance on two earlier and two subsequent consecutive non-fast days. The impact of hunger and distraction on mood and perceived work performance were subsequently investigated using regression.

Participants

Sixteen lean female students (aged 18-22 years, BMI 20.2-23.9 kg/m2) took part in the study. All participants were non-smokers, in good physical and mental health, and not on any energy restricting diet. Young females were involved in the study due to the high likelihood of food restriction in this group (e.g. Malinauskas, Raedeke, Aeby, Smith & Dallas, 2006; Mooney, Farley & Strugnell, 2004), therefore enabling high likely relevance and likely high compliance with study procedures. All participants were fully informed of all study procedures prior to commencement in the study, and provided informed consent. The study was approved by the Research Ethics Committee of Bournemouth University, and run in accordance with the Ethical Guidelines of the British Psychological Society and the Declaration of Helsinki (2000).

Intermittent fasting

Participants were asked to undertake two consecutive days of fasting, where consumption of no more than 500 kcal. was permitted. Participants were given comprehensive guidance on the amount of food required to consume 500 kcal., and consumption on each fast day was verified by the researcher by questioning all foods consumed. These questions and questions about questionnaire completion

revealed that all participants adhered to the experimental protocol. Consecutive fast days were utilized to allow investigation of compound effects on the second day of fasting should these arise.

Both the week before fasting and the week after fasting, participants were asked to consume their normal diet. All measures taken on fast days were also taken on the same two days of the week during these weeks (e.g. Tuesday, Wednesday), as non-fast day comparisons. A period of one week between measures was used to avoid direct compensation effects, and allow a more accurate measure of usual hunger, distraction, mood, and perceived work performance. Use of the same two days of each week for all measurements was intended to control for effects due to routine.

Hunger, Distraction, Mood and Performance

Hunger, distraction, mood and perceived work performance were measured at 6pm on each study day, using 100mm visual analogue scales, anchored from 'not at all' to 'extremely'. Hunger was measured using two questions assessing: current hunger - '*How hungry are you feeling?',* and whole day hunger - *'How hungry have you felt throughout the day?'.* Distraction was measured using five questions assessing: current distraction - '*How attentive are you feeling?' (reversed scored),* and whole day distraction - *'How distracted do you feel you have been today?', 'How focused on particular tasks have you felt today?'* (reversed scored)*, 'How often do you feel you've been daydreaming today?',* and *'How difficult have you found it to concentrate today?'.* Mood was measured using the ten positive and ten negative items of the Positive and Negative Affect Scales (PANAS) (Watson, Clark & Tellegen, 1988). Perceived work performance was measured using three items: '*How productive do you feel you've been today?', 'How satisfied are you with the amount of work you have completed today?',* and *'How satisfied are you with the quality of the work you have completed today?'.*

Scale responses were combined and averaged to provide one score per participant per day for current hunger, whole day hunger, current distraction, whole day distraction, positive mood, negative mood, and perceived work performance. For all scales a higher score denoted stronger feeling. Questions on hunger, distraction, mood and perceived work performance were taken from published studies (e.g. Hill et al, 1995; Watson et al, 1988) or developed specifically for this study. Cronbach's alpha's for all composite scales demonstrated good reliability (smallest alpha=0.71).

All mood items were completed first, then the questions on current distraction and current hunger, then all perceived work performance items, and finally the questions on whole day distraction and whole day hunger. Distraction and then hunger questions were placed at the end of each section to avoid carry-over effects onto other questions.

RESULTS

Data were initially analysed by repeated measures ANOVA to demonstrate impacts of fasting (fasting vs. pre-fast non-fasting vs. post-fast non-fasting) and day of measurement (day 1 vs. 2) on hunger, distraction, mood and perceived work performance. This analysis investigated simple group-based differences between conditions as a result of fasting. Secondly, data were analysed using clustered regression, where participant ID acted as the cluster variable. Clustered regression acknowledges the correlation, and consequent lower within-cluster variation within clusters (or non-independent data points), and was used to allow multiple data points from each participant to be used for analysis (Desai & Begg, 2008). This resulted in the availability of 96 data points for analysis. In analyses on mood, regression models were used to predict mood, using in model 1 - fasting state (fast/non-fast) and day of measurement (1/2); and in model 2 - fasting state (fast/non-fast), day of measurement (1/2), current hunger, whole day hunger, current distraction and whole day distraction. In analyses on perceived work

performance, regression models were used to predict perceived work performance, using in model 1 - fasting state (fast/non-fast), and day of measurement (1/2); in model 2 - fasting state (fast/non-fast), day of study (1/2), current hunger, whole day hunger, current distraction and whole day distraction; and in model 3 - fasting state (fast/non-fast), day of measurement (1/2), current hunger, whole day hunger, current distraction, whole day distraction, positive mood and negative mood. Two and three step regression models were used to investigate independent effects of fasting, hunger and distraction on mood and perceived work performance. No differences were found between pre- and post-fasting non-fast days in ANOVA analyses, thus these were combined for all regression analyses. Correlations between current hunger and whole day hunger ($r=0.65$), between current distraction and whole day distraction ($r=0.53$), and between hunger and distraction (largest $r=0.42$) were not so high as to suggest potential multi-co-linearity if included in the same model. Analyses were conducted in Stata (StataCorp, Inc.).

Means for all outcomes variables are given in Table 1. Records on fast days demonstrated greater current hunger, greater whole day hunger, greater current distraction, greater whole day distraction, lower positive mood, greater negative mood, and lower perceived work performance compared to non-fast days (smallest $F(2,30)=8.60$, $p=0.01$).

Table 1 about here

Results of regression analyses for mood are given in Table 2. Higher positive mood was initially associated with non-fasting as opposed to fasting ($\beta=18.67$, 95% CIs 13.77, 23.57, $p<0.01$), and with the second day of measurement as opposed to the first ($\beta=3.56$, 95% CIs 0.54, 6.56, $p=0.03$). On inclusion of hunger and distraction variables however, the effect of fasting disappeared ($\beta=1.38$, 95% CIs -8.59,

11.35, p=0.77), and higher positive mood was associated with the second day of measurement (β=3.66, 95% CIs 0.34, 6.98, p=0.03), and lower current distraction (β=-0.38, 95% CIs -0.46, -0.29, p<0.01).

Higher negative mood was initially associated with the second day of measurement (β=2.34, 95% CIs 0.56, 4.11, p=0.01), and on inclusion of hunger and distraction variables was also only associated with second day of measurement (β=3.79, 95% CIs 1.19, 6.39, p=0.01).

Table 2 about here

Results of regression analyses for perceived work performance are given in Table 3. Greater perceived work performance was initially associated with non-fasting as opposed to fasting (β=23.19, 95% CIs 12.11, 34.27, p<0.01). On inclusion of hunger and distraction variables, this effect disappeared (β=-1.13, 95% CIs -18.24, 15.99, p=0.89), and greater perceived work performance was associated with second day of measurement (β=5.90, 95% CIs 0.75, 11.06, p=0.03), lower current distraction (β=-0.25, 95% CIs -0.47, -0.03, p=0.03) and lower whole day distraction (β=-0.49, 95% CIs -0.74, -0.24, p<0.01). On inclusion also of mood variables, associations with day of measurement and current distraction disappeared (day: β=3.85, 95% CIs 0.45, 8.15, p=0.08; current distraction: β=-0.03, 95% CIs -0.34, 0.28, p=0.83), but greater perceived work performance was associated with lower whole day distraction (β=-0.50, 95% CIs -0.69, 0.32, p<0.01) and higher positive mood (β=0.59, 95% CIs 0.17, 1.00, p=0.01).

Table 3 about here

DISCUSSION

Firstly, these results demonstrate lower positive mood, higher negative mood and lower perceived work

performance on fast days compared with non-fast days. These effects have been demonstrated repeatedly previously in relation to dieting and fasting (Benton & Parker, 1998; Green, et al, 1997; Green & Rogers, 1995; Hagan, et al, 2000; Keys, et al, 1950; Laessle, et al, 1996; McFarlane, et al, 1999; Sunram-Lea, et al, 2010), and are demonstrated here after just one and two days of fasting.

Secondly, the effects of fasting on mood and perceived work performance were found to result largely from the consequent distraction, as opposed to the act of fasting or the resulting hunger. In final regression models for both mood and perceived work performance, initial effects of fasting were accounted for entirely by effects of distraction, and neither fasting state nor hunger were significantly associated with mood or perceived work performance, while distraction was. An important role for distraction in the effects of fasting and dieting on mood and performance has previously been suggested (Green et al, 1997; Green & Rogers, 1995; Jones & Rogers, 2003), but this is the first study of which we are aware that has distinguished between effects of the act of fasting, effects of hunger and effects of distraction, and demonstrates effects only for distraction. Effects in this study are also of particular interest due to the use of intermittent fasting, a form of dieting considered to require less attention (and so to result in less distraction) than traditional dieting.

The act of fasting presumably impacts on energy intake, and reduced blood sugar has previously been suggested as a route through which dieting and fasting may impact on mood and performance (Benton, 2002; Benton & Parker, 1998). Our study findings suggest that this reduced blood sugar impacts on mood and perceived work performance, not through hunger or physiological deprivation, but through an increased cognitive load as a result of an increased attention toward food and eating. Others have also suggested that the minimal amount of weight often lost during dieting also implies limited physiological deprivation (Green et al, 1997; Green & Rogers, 1995; Laessle et al, 1996), suggest limited

impact as a result of physiological deprivation (Green et al, 1997; Green & Rogers, 1995; Laessle et al, 1996), and suggest increased cognitive load and a redirection of attention as a result of dieting/fasting (Green et al, 1997; Green & Rogers, 1995; Jones & Rogers, 2003).

Positive mood was also associated with day of measurement, where positive mood was higher on the second day of measurement compared to the first, suggesting some tolerance to the fasting regime. Previous work has also suggested that one of the benefits of intermittent fasting might be the short term nature of the fasting element (Collier, 2013; Laessle et al, 1996; Polivy, 1998). Negative mood, however, was also higher on the second day of measurement compared to the first, thus the effects of day of measurement may reflect more an adaption to the measures or the study procedures.

Perceived work performance was also associated, not only with distraction, but also with positive mood. The impact of mood on performance is well recognized in the occupational as well as health psychology literature (Arnold & Randall, 2010; Millward, 2005; Ogden, 2007), but the direction of effects between mood and perceived work performance, can not be clearly distinguished from a cross-sectional analysis such as that used here, and may be reversed. While the deliberate manipulation of fasting suggests that effects on both mood and perceived work performance are a result of the fasting, it is possible that effects of mood on perceived work performance are in fact effects of perceived work performance on mood, or a result of a mutual determinant such as distraction. As positive mood was associated with current distraction and day of measurement, it could be argued that perceived work performance is in fact also predominantly associated with distraction.

Negative mood was affected by fasting (as demonstrated in ANOVA analyses), but was not associated significantly with hunger or distraction. These findings may suggest a particular role for distraction only

in positive perceptions, but the lack of effects on negative mood is possibly alternatively a result of the low levels of negative mood in general in the study. Negative moods are likely to be higher over longer dieting/fasting time periods and/or in individuals who are dieting/fasting by choice compared to those on a two day schedule for a three week study. Longer studies and studies involving individuals who self select to follow an intermittent fasting regime would clearly be of interest.

The study is limited in its use of a limited number of participants, and the absence of individuals on a traditional diet where effects of hunger and distraction are also investigated. The study was undertaken as a pilot study, and a larger study with a traditional dieting control was envisaged if limited effects of distraction were suggested here. The use only of lean young females may also be considered a limitation. This population group was used to test a theoretical hypothesis, due to their likely high compliance, as well as the high relevance of this group for real world implications. Study of other population groups who are also likely to diet/fast, e.g. those overweight, would also be of interest from a public health perspective, although greater variance between individuals and greater impacts from other weight-related variables may mask relative effects due to hunger and distraction. We have also preferred to use simple step-based regression analyses to demonstrate effects, as opposed to more complex analyses such as mediation analyses or boot strapping. Mediation analyses were avoided to allow the investigation of independent effects due to the act of fasting (in mediation analyses these effects would have to be assumed), and more complex analyses were not used to avoid over-interpretation of data from a limited pilot study.

In conclusion, this study demonstrated impacts of fasting on mood and perceived work performance in association with distraction, where poorer positive mood and poorer perceived work performance on fast days compared to non-fast days were associated with higher distraction, as opposed to the act of

fasting or higher hunger. This distraction is considered to occur as a result of the attention required for fasting. This study thus suggests that intermittent fasting offers no benefits for mood or perceived work performance over traditional dieting as a result of reduced distraction during fast days. Benefits for intermittent fasting may be achieved as a result of the reduced time period of energy restriction and the reduced psychological deprivation, but these hypotheses need testing before they are advocated.

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Table 1: Mean (and standard deviation) ratings for all measures.

Measure	Fast	Fast	Non-Fast	Non-Fast
	Day 1	Day 2	Day 1	Day 2
Current hunger (0-100)	78 (18)	71 (17)	53 (26)	31 (26)
Daily hunger (0-100)	74 (18)	76 (17)	45 (25)	34 (20)
Current distraction (0-100)	75 (17)	79 (12)	42 (20)	47 (26)
Daily distraction (0-100)	63 (16)	67 (18)	37 (14)	38 (20)
Positive mood (0-100)	30 (11)	27 (10)	44 (14)	50 (14)
Negative mood (0-100)	21 (13)	25 (15)	20 (11)	22 (11)
Work performance (0-100)	31 (24)	32 (20)	51 (18)	58 (19)

Table 2: Results of the regression analyses for positive and negative mood

Positive Mood	Model 1		Model 2	
	Variables	Statistics β (95% CIs), p	Variables	Statistics β (95% CIs), p
	Fast state	**18.67 (13.77, 23.57), p<0.01**	Fast state	1.38 (-8.59, 11.35), p=0.77
	Day	**3.56 (0.54, 6.56), p=0.03**	**Day**	**3.66 (0.34, 6.98), p=0.03**
			Current hunger	-0.05 (-0.22, 0.11), p=0.48
			Daily hunger	-0.11 (-0.27, 0.04), p=0.15
			Current distraction	**-0.38 (-0.46, -0.29), p<0.01**
			Daily distraction	0.03 (-0.15, 0.21), p=0.73
Negative Mood	Model 1		Model 2	
	Variables	Statistics β (95% CIs), p	Variables	Statistics β (95% CIs), p
	Fast state	-2.46 (-7.26, 2.33), p=0.29	Fast state	6.21 (-1.91, 14.33), p=0.12
	Day	**2.34 (0.56, 4.11), p=0.01**	**Day**	**3.79 (1.19, 6.39), p=0.01**
			Current hunger	0.10 (-0.03, 0.22), p=0.12

			Daily hunger	0.03 (-0.11, 0.17), p=0.66
			Current distraction	0.003 (-0.16,0.16), p=0.97
			Daily distraction	0.16 (-0.08, 0.41), p=0.18

Table 3: Results of the regression analyses for perceived work performance

Model 1		Model 2		Model 3	
Variables	Statistics β (95% CIs), p	Variables	Statistics β (95% CIs), p	Variables	Statistics β (95% CIs), p
Fast state	**23.19 (12.11, 34.27), p<0.01**	Fast state	-1.13 (-18.24, 15.99), p=0.89	Fast state	-1.79 (-16.09, 12.52), p=0.79
Day	4.78 (-0.02, 9.59), p=0.06	**Day**	**5.90 (0.75, 11.06), p=0.03**	Day	3.85 (0.45, 8.15), p=0.08
		Current hunger	-0.05 (-0.19, 0.09), p=0.44	Current hunger	-0.02 (-0.12, 0.09), p=0.71
		Daily hunger	-0.03 (-0.25, 0.19), p=0.79	Daily hunger	0.04 (-0.20, 0.27), p=0.75
		Current distraction	**-0.25 (-0.47, -0.03), p=0.03**	Current distraction	-0.03 (-0.34, 0.28), p=0.83
		Daily distraction	**-0.49 (-0.74, -0.24), p<0.01**	**Daily distraction**	**-0.50 (-0.69, -0.32), p<0.01**
				Positive mood	**0.59 (0.17, 1.00), p=0.01**
				Negative mood	-0.02 (-0.29, 0.24), p=0.85