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ABSTRACT

There is evidence to suggest that impulsivity is predicted by socioeconomic background, with people from more deprived backgrounds tending to be more impulsive, and by current mood, with poorer mood associated with greater impulsivity. However, impulsivity is not a unitary construct, and previous research in this area has focused on measures of 'waiting' impulsivity rather than behavioural disinhibition. We administered a standard measure of behavioural disinhibition, the stop-signal task, to 58 adult participants from a community sample. We had measured socioeconomic background using participant postcode at age 16, and assigned participants to receive either a neutral or a negative mood induction. We found no effects of mood on behavioural disinhibition, but we found a significant effect of socioeconomic background. Participants with more deprived postcodes at age 16 showed longer stop-signal reaction times, and hence greater behavioural disinhibition. The pattern was independent of participant age and overall reaction time. Greater behavioural disinhibition may be a consequence of experiencing childhood socioeconomic deprivation, and could play a role in maintaining social gradients in outcomes such as addiction.

Keywords: impulsivity, behavioural inhibition, stop-signal, social gradients, socioeconomic deprivation, addiction

INTRODUCTION

Impulsivity is an important psychological trait, because it has been linked to a number of outcomes which are problematic from both individual and societal perspectives, such as addiction and criminal behaviour (Pratt & Cullen, 2000; Perry & Carroll, 2008; Moffitt et al., 2011; Sharma, Markon & Clark, 2014). Recent evidence suggests that socioeconomic position and negative affect may be two important determinants of impulsivity. A substantial number of studies have presented evidence that individuals of lower socioeconomic position tend to be more impulsive than those of higher socioeconomic position (Lawrance, 1991; Green et al., 1996; Adams & White, 2009). Though causality is difficult to establish definitively, the relationship his thought to be at least partly causal (Haushofer & Fehr, 2014). That is, experiencing socioeconomic hardship makes people become more impulsive, rather than, for example, more impulsive people being downwardly economically mobile. Other studies have shown that negative mood can also make people more impulsive (Lerner, Li & Weber, 2012). Here, the causality is much easier to demonstrate, since negative mood can be induced experimentally, and the consequent increase in impulsivity measured. The socioeconomic and mood effects on impulsivity may well be linked; part of the reason that people of lower socioeconomic position are characterised as more impulsive may be that their mood is more negative much of the time (Haushofer & Fehr, 2014). However, whether there is also a ‘mood-independent’ effect of socioeconomic position on impulsivity is not at present well understood.

Impulsivity, however, is not a unitary trait (Reynolds et al., 2006; Sharma, Markon & Clark, 2014; Stahl et al., 2014). Although a number of typologies of impulsivity have been proposed, a common distinction is between the unwillingness to wait for a deferred outcome (‘waiting impulsivity’ or impulsive choice) and the inability to stop oneself from making a response that has been cued or initiated by the context (‘stopping impulsivity’, impulsive action, or behavioural disinhibition) (Reynolds et al., 2006; Perry & Carroll, 2008; Brevers et al., 2012). Although both types are often referred to as impulsivity in the literature, measures of waiting impulsivity do not tend to be substantially correlated with measures of behavioural disinhibition (Reynolds et al., 2006). Almost all of the evidence on socioeconomic position and current mood as predictors of impulsivity comes from waiting impulsivity tasks. For behavioural disinhibition, one study found no socioeconomic patterning in a large community sample of children and adolescents (Crosbie et al., 2013). Beyond this, there is little research looking for a socioeconomic gradient, and there have been no experimental studies manipulating mood to examine the consequences for behavioural disinhibition. In this study, we therefore administered a standard measure of behavioural disinhibition, the stop-signal task (SST), to adults from a community sample, having first measured their socioeconomic background, and randomly assigned them to receive either a negative mood induction or a control procedure.

In the SST, participants complete many trials where they must respond with a key press to a go-cue displayed on a computer screen. On a minority of trials, and unpredictably, a stop-cue is also displayed. In these trials, the participant is instructed not to press the key. By varying the temporal offset between the appearance of the go-cue and the appearance of the stop-cue on the stop trials, it is possible to estimate the participant's stop-signal reaction time (SSRT). This is the characteristic time required for the person to successfully make an inhibitory response. A longer SSRT equates to poorer behavioural inhibition (or, equivalently, greater behavioural disinhibition). The theoretical assumptions underlying the task have been confirmed (Logan & Cowan, 1984; Logan, Cowan & Davis, 1984), and SSRT scores have been externally validated in studies of drug addiction (Fillmore et al., 2002). As well as the SSRT itself, the SST yields for each participant an average reaction time for the go trials (the GRT). This is a potentially important covariate, since individual differences in SSRT may simply reflect variation in reaction time to the go-cue rather than inhibition abilities *per se*. It is also important, when analysing SSRT and GRT, to control for participant age, since both reaction times have been shown to increase with age in adulthood (Williams et al., 1999; Bedard et al., 2010).

There are multiple ways of conceptualizing and assessing socioeconomic position. Recent studies have suggested that exposure to deprived neighbourhoods across childhood may be a key predictor of psychological outcomes (Sampson, Sharkey & Raudenbush, 2008; Sastry & Pebley, 2010; Sharkey & Elwert, 2011). We thus chose to focus on neighbourhood socioeconomic deprivation rather than individual socioeconomic status, and measured at the end of childhood rather in adulthood. We therefore decided to use residential postcodes from age 16 to obtain a neighbourhood deprivation score. The UK has high-quality deprivation data resolved to a small spatial scale, based on the average of indices across multiple domains of deprivation. For the mood induction, we used the Velten procedure, a widely-used technique where the participant reads a sequence of either neutral or negatively-valenced statements according to the condition they have been assigned to (Velten, 1968). The negative condition induces a global negative mood.

Our predictions were that participants from more deprived backgrounds, and participants assigned to the negative condition, would show relatively longer SSRTs, once appropriate control was made for age and GRT. We noted the possibility that there might also be interactions between socioeconomic background and mood condition, since some recent studies have suggested that people from different socioeconomic backgrounds react differently to cues of current adversity (Griskevicius et al., 2013). We thus included interactions between mood condition and socioeconomic background in our models.

METHODS

Ethics and Participants

The study was authorised by the Newcastle University Faculty of Medical Sciences Ethics Committee under approval number 00655/2013. Participants were an opportunity sample of individuals who had grown up in the UK, recruited by means of the Institute of Neuroscience participant pool, Newcastle University. This is a large database of email addresses of people who have shown an interest in taking part in neuroscience or medical research. It includes students, staff of the university, and other residents of the city, and is thus reasonably diverse in terms of ages and socioeconomic backgrounds. A compensation of £5 was offered in exchange for participation. The data includes two samples gathered in separate years by TC and TP respectively. All procedures were identical in the two sub-samples. We have repeated all analyses in this paper with experimenter as an additional random effect, and none of the results is altered. A total of 58 people participated (65.5 % female; age (in years) M = 32.77, SD = 14.8).

Procedure

Participants were tested individually in a single session in a curtained cubicle within a computer laboratory. The experimenter withdrew from the cubicle during the tasks. On a desk in front of the participant was a desktop computer with speakers and keyboard. Standard computer keyboards have slow polling rates that render them unsuitable for tasks requiring highly accurate timing (Plant, Hammond & Whitehouse, 2003; Verbruggen, Logan & Stevens, 2008), and so we used a Razer 'Lycosa' games keyboard with a specified polling rate of 1000Hz. The sequence of steps was as follows: participants read the study information sheet and signed a consent form; completed a computerised demographic questionnaire and baseline mood measure; completed the mood induction task; completed the SSRT; and finally completed another mood measure as a manipulation check. On completion, each participant was debriefed and received the compensation payment.

Demographic questionnaire and baseline mood measure. The initial questionnaire, delivered via the Qualtrics survey platform (www.qualtrics.com), asked participants to report their age, sex, the postcode of the address that they had lived in at age 16, and their current mood on a scale of 1-100, where 1 was the most negative possible and 100 the most positive.

Mood induction procedure. On completion of the initial questionnaire, Qualtrics pseudorandomly assigned participants to either the negative or neutral conditions. The experimenter was thus blind to the experimental condition. Those in the negative condition saw a sequence of 50 statements from the negative Velten mood induction (Velten, 1968). These describe negative sentiments, and their severity increases as the sequence of statements goes on. Participants in the neutral condition saw a sequence of 50 statements matched to the neutral ones for linguistic properties but devoid of any emotional valence. Each statement was presented on the screen for six seconds, and the participants were instructed to try to memorise them. After the sequence had finished, the participants alerted the experimenter, who started up the SSRT programme.

Stop signal task. We delivered the SST using STOP-IT software (Verbruggen, Logan & Stevens, 2008). In this implementation, the go-cue is a square or circle displayed in the middle of the screen; two response keys on the keyboard were marked with a square and circle respectively, and the participant instructed to press the correct one as quickly as possible. The stop signal is an audible tone. STOP-IT was run in full-screen mode, with system volume set to full and speaker volume at 2/3. The default task parameters were used: 1 practice block of 32 trials, followed by 3 experimental blocks of 64 trials each. Each trial begins with a 250ms fixation cue, followed by the go-cue, which is displayed until the participant responds, with a maximum limit of 1250ms. The inter-trial interval is 2000ms. Stop-trials constitute 25% of all trials; the difference in onset time of stop-cue relative to go-cue on these trials is automatically titrated dependent on performance to provide an estimate of the delay at which that participant has a 50% chance of inhibiting successfully. The participant's SSRT is calculated from the value of this delay.

After the experimenter had explained the instructions, participants pressed a key when they were ready to start the task. The experimenter observed the participant during the practice block to see whether they were responding correctly. The participant then completed the 3 experimental blocks, which the experimenter did not observe. Following the practice block and each one of the trial blocks, a summary screen showing the participant's response suppression rate, trials missed and errors made was displayed during a 10-second delay until the participants could press a key to begin the next task. After the final block, the participants alerted the experimenter.

Manipulation check mood measure. As the final step of the experiment, the participants were asked to rate their mood again on a scale of 1 to 100 via the Qualtrics survey window on the computer. The experimenter was careful not to observe, or be seen to be observing, the answer to this question.

Data Analysis

Raw data are available as Supplementary Material. SSRT was calculated using the ANALYZE-IT programme supplied with STOP-IT (Verbruggen, Logan & Stevens, 2008). All participants provided data that met the assumptions required by STOP-IT to generate a valid SSRT and GRT. Postcode at age 16 was converted to a deprivation score via the Neighbourhood Statistics database (https://neighbourhood.statistics.gov.uk/).

First, we extracted for each postcode a deprivation rank; this is the rank in terms of multiple deprivation of the lower super output area corresponding to the postcode, from 1 (most deprived in UK) to 32482 (least deprived). We converted this into a more intuitively interpretable deprivation score using the formula:

Deprivation score = 1 – (deprivation rank / 32482)

Thus, the median UK neighbourhood would have a deprivation score of 0.5, the most deprived a score of 1, and the least deprived a score of 0. Once the measures had been calculated, data were analysed in R (R Core Development Team, 2013), using general linear models and t-tests as appropriate. SSRTs were mildly right-skewed. All models reported below were also run using log-transformed SSRT, which corrects the right skew. Since results were essentially identical, the non-transformed results have been reported. Residuals were checked in all cases, and there were no major violations of parametric model assumptions.

RESULTS

Descriptive statistics

Table 1 shows the descriptive statistics by condition for variables other than performance in the stop-signal task. There were no significant differences by condition in age, deprivation, or baseline mood, as there should not have been, since condition was randomly assigned. Average deprivation scores were close to the UK median neighbourhood (0.45), but with a good range (0.11 – 0.98). Deprivation score was not significantly associated with baseline mood ($r_{56} = 0.07$, $p = 0.62$).

Mood manipulation check

The mood induction produced a modest decrease in mood between baseline and final rating in the negative condition (*M* = -3.23; *SD* = 5.27), and a modest improvement in mood in the neutral condition (*M* = 2.78; *SD* = 13.31). The condition difference in mood change was statistically significant ($t_{56} = -2.29$, $p=0.03$). However, the final mood ratings were not significantly different between the negative and neutral conditions (Negative: M = 77.1, SD = 18.1; Neutral: M = 74.5, SD = 17.3, $t_{56} = 0.56$, $p=0.58$). This is due to variation in initial mood diluting the modest effect of the mood manipulation. For this reason, in all subsequent analyses, we include both experimental condition and baseline mood as independent variables. We also repeated the analyses using final mood in place of condition and baseline mood, but no conclusions were changed.

Go-reaction time (GRT)

We fitted a general linear model to the GRTs, with age, initial mood, condition, deprivation score and the condition by deprivation score interaction as predictors. The model summary is shown in the upper part of table 2. Age predicted GRT, with GRTs becoming slower with increasing age, but there were no significant effects of initial mood, condition or deprivation score on GRT.

Stop-signal reaction time (SSRT)

The general linear model for SSRT included as predictors GRT, age, initial mood, condition, deprivation score, and the condition by deprivation score interaction. The model summary is shown in the lower part of table 2. There was a significant effect of GRT, with participants who were faster on the go-trials having a longer SSRT. There was also a predicted effect of age, with older participants having longer SSRTs. There was a significant effect of deprivation score, with participants from more deprived postcodes having longer SSRTs (figure 1). The effects of initial mood, condition, and the condition by deprivation interaction were not significant.

DISCUSSION

In a community sample of adults, we found evidence that behavioural disinhibition, as measured using the SSRT task, was related to socioeconomic background. Participants who had lived in more deprived postcodes at age 16 had longer SSRTs, and hence showed greater behavioural disinhibition, than participants who had lived in more affluent postcodes. We also measured mood, and manipulated it using a standard mood-induction procedure, but we found no evidence that current mood - either the naturally-occurring variation in baseline mood, or our experimentally-produced mood manipulation - affected SST performance in any way. Thus, our predictions concerning the relationship between socioeconomic deprivation and behavioural disinhibition were supported, whilst our predictions concerning the role of current mood were not. Our results also concurred with those of previous investigations in finding that SSRTs, as well as GRTs, increased substantially with age (Williams et al., 1999; Bedard et al., 2010). We also found that SSRT was negatively related to GRT; people who were faster to act in the go-trials were, other things being equal, slightly more disinhibited. However, the deprivation-disinhibition relationship was not explained by differences in GRT; it persisted even once variation in GRT was controlled for.

A number of previous studies have demonstrated socioeconomic gradients in measures of ‘waiting’ impulsivity, the relatively steep devaluing of future rewards compared to immediate ones (Lawrance, 1991; Green et al., 1996; Adams & White, 2009). To our knowledge, this is the first evidence that there may also be a socioeconomic gradient in ‘stopping impulsivity’ or behavioural disinhibition. Demonstrating the existence of such a gradient is potentially important, since behavioural disinhibition predicts problematic real-world outcomes above and beyond 'waiting' impulsivity alone (Brevers et al., 2012; Sharma, Markon & Clark, 2014).

Why socioeconomic gradients in impulsivity should exist is not well understood. They could be driven by socioeconomic variation in general cognitive ability. In the current data, this seems unlikely to be the case, since there was no gradient in reaction times on the go trials, which one might have expected if there was a gradient in general cognitive performance. However, without more robust measurement of general cognitive ability, this possibility cannot be dismissed. Another recent proposal is that relationships between socioeconomic position and impulsivity might be mediated by differences in mood (Haushofer & Fehr, 2014). However, this cannot be the case here, since there was no socioeconomic gradient in baseline mood, and we found no evidence for any effect of mood on behavioural disinhibition. This is in contrast to a previous experimental study that found effects of mood manipulation on waiting impulsivity (Lerner, Li & Weber, 2012). Thus, our data suggest an embedded effect of socioeconomic deprivation on disinhibition that is independent of current mood. Socioeconomic position is associated with many different aspects of experience, from housing to diet to family composition, and exactly what it is about deprivation that tends to produce greater disinhibition as well as a relatively stronger preference for immediate over delayed outcomes remains to be explored.

Our study had a number of limitations. Our sample was not constructed in such a way as to guarantee socioeconomic representativeness. However, we were fortunate in that the mean deprivation score of our sample was roughly in the middle of the UK range, and both extremes were represented in the data. We measured deprivation through postcode at the end of childhood. We chose this as we anticipated recruiting mainly young adults, and we felt this would be the single most convenient and valid measure for this age group. In fact, we recruited more, older people than anticipated, and childhood postcode at 16 is a less ideal measure for these participants than for younger ones. For one thing, their age 16 is longer ago, and the neighbourhoods may have changed in the intervening years. We made no attempt to distinguish statistically between childhood deprivation and adult deprivation. It could be that the most important predictor of behavioural disinhibition is *current* experience of deprivation (Nettle et al., 2014), and the relationship we found with childhood deprivation might be because people with more deprived childhood backgrounds also go on to experience more deprivation in adulthood. To discriminate whether current or childhood experience of deprivation is important, the two would need to be separately measured to establish which has the greater predictive power. Our measure also did not distinguish individual-level socioeconomic characteristics such as parental income and education from neighbourhood-level deprivation. The two are likely to be highly correlated, but our study does not licence inferences about which of these, if either, is responsible for the observed association. We should also be cautious about inferring causality from an association; though it seems reasonable that something about childhood deprivation might cause the development of greater disinhibition, other explanations for the correlation cannot be excluded.

Our mood manipulation, though it employed a standard technique that has been used in other recent studies (Smallwood & O'Connor, 2011; Scherrer, Dobson & Quigley, 2014), produced only very modest effects on participants' final mood. It is possible that a stronger manipulation of mood might have affected behavioural disinhibition. However, there was considerable variation in baseline mood, and the combination of baseline mood and the manipulation still did not explain any variation in behavioural disinhibition. This suggests that across a substantial range of mood, mood effects on behavioural disinhibition, if they exist, must be very small.

Despite the limitations noted above, it is striking that in a relatively small sample, and with a relatively crude measure of socioeconomic background, we found evidence of an association between the experience of deprivation and behavioural disinhibition. Childhood socioeconomic deprivation is an epidemiological predictor of a number of important outcomes such as subsequent crime (Levine, 2011), and transition to habitual use of drugs and tobacco (Legleye et al., 2011). Behavioural disinhibition plausibly plays a role in these outcomes. Thus, behavioural disinhibition could be an important psychological mechanism linking childhood socioeconomic conditions to subsequent life outcomes.

REFERENCES

Adams J, White M. 2009. Time perspective in socioeconomic inequalities in smoking and body mass index. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association* 28:83–90.

Bedard A-C, Nichols S, Jose A, Schachar R, Logan GD, Tannock R. 2010. The Development of Selective Inhibitory Control Across the Life Span. *Developmental Neuropsychology* 21:93–111.

Brevers D, Cleeremans A, Verbruggen F, Bechara A, Kornreich C, Verbanck P, Noël X. 2012. Impulsive Action but Not Impulsive Choice Determines Problem Gambling Severity. *PLoS ONE* 7:5–12.

Crosbie J, Arnold P, Paterson A, Swanson J, Dupuis A, Li X, Shan J, Goodale T, Tam C, Strug LJ, Schachar RJ. 2013. Response inhibition and ADHD traits: Correlates and heritability in a community sample. *Journal of Abnormal Child Psychology* 41:497–507.

Fillmore MT, Fillmore MT, Rush CR, Rush CR. 2002. Impaired inhibitory control of behavior in chronic cocaine users. *Drug and alcohol dependence* 66:265–73.

Green L, Myerson J, Lichtman D, Rosen S, Fry A. 1996. Temporal discounting in choice between delayed rewards: The role of age and income. *Psychology and Aging* 11:79–94.

Griskevicius V, Ackerman JM, Cantú SM, Delton AW, Robertson TE, Simpson JA, Thompson ME, Tybur JM. 2013. When the economy falters, do people spend or save? Responses to resource scarcity depend on childhood environments. *Psychological science* 24:197–205.

Haushofer J, Fehr E. 2014. On the psychology of poverty. *Science* 344:862–867.

Lawrance EC. 1991. Poverty and the Rate of Time Preference: Evidence from Panel Data. *Journal of Political Economy* 99:54.

Legleye S, Janssen E, Beck F, Chau N, Khlat M. 2011. Social gradient in initiation and transition to daily use of tobacco and cannabis during adolescence: A retrospective cohort study. *Addiction* 106:1520–1531.

Lerner JS, Li Y, Weber EU. 2012. The Financial Costs of Sadness. *Psychological Science* 24:72–79.

Levine SZ. 2011. Elaboration on the association between IQ and parental SES with subsequent crime. *Personality and Individual Differences* 50:1233–1237.

Logan GD, Cowan WB. 1984. On the ability to inhibit thought and action: A theory of an act of control. *Psychological Review* 91:295–327.

Logan GD, Cowan WB, Davis KA. 1984. On the ability to inhibit simple and choice reaction time responses: A model and a method. *Journal of Experimental Psychology: Human Perception and Performance* 10:276–291.

Moffitt TE, Arseneault L, Belsky D, Dickson N, Hancox RJ, Harrington H, Houts R, Poulton R, Roberts BW, Ross S, Sears MR, Thomson WM, Caspi A. 2011. A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences of the United States of America* 108:2693–2698.

Nettle D, Pepper G V, Jobling R, Schroeder KB. 2014. Being there : a brief visit to a neighbourhood induces the social attitudes of that neighbourhood. :1–20.

Perry JL, Carroll ME. 2008. The role of impulsive behavior in drug abuse. *Psychopharmacology* 200:1–26.

Plant RR, Hammond N, Whitehouse T. 2003. How choice of mouse may affect response timing in psychological studies. *Behavior Research Methods, Instruments, & Computers* 35:276–284.

Pratt TC, Cullen FT. 2000. The empirical status of Gottfredson and Hirschi's general theory of crime: A meta-analysis. *Criminology* 38:931–964.

R Core Development Team. 2013. R: A Language and Environment for Statistical Computing.

Reynolds B, Ortengren A, Richards JB, de Wit H. 2006. Dimensions of impulsive behavior: Personality and behavioral measures. *Personality and Individual Differences* 40:305–315.

Sampson RJ, Sharkey P, Raudenbush SW. 2008. Durable effects of concentrated disadvantage on verbal ability among African-American children. *Proceedings of the National Academy of Sciences of the United States of America* 105:845–52.

Sastry N, Pebley AR. 2010. Family and neighborhood sources of socioeconomic inequality in children's achievement. *Demography* 47:777–800.

Scherrer MC, Dobson KS, Quigley L. 2014. Predictors of self-reported negative mood following a depressive mood induction procedure across previously depressed, currently anxious, and control individuals. *The British journal of clinical psychology / the British Psychological Society* 53:348–68.

Sharkey P, Elwert F. 2011. The legacy of disadvantage: multigenerational neighborhood effects on cognitive ability. *AJS; American journal of sociology* 116:1934–81.

Sharma L, Markon KE, Clark LA. 2014. Toward a theory of distinct types of "impulsive" behaviors: A meta-analysis of self-report and behavioral measures. *Psychological bulletin* 140:374–408.

Smallwood J, O'Connor RC. 2011. Imprisoned by the past: unhappy moods lead to a retrospective bias to mind wandering. *Cognition & emotion* 25:1481–90.

Stahl C, Voss A, Schmitz F, Nuszbaum M, Tüscher O, Lieb K, Klauer KC. 2014. Behavioral components of impulsivity. *Journal of experimental psychology. General* 143:850–86.

Velten E. 1968. A laboratory task for induction of mood states. *Behaviour Research and Therapy* 6:473–482.

Verbruggen F, Logan GD, Stevens M a. 2008. STOP-IT: Windows executable software for the stop-signal paradigm. *Behavior Research Methods* 40:479–483.

Williams BR, Ponesse JS, Schachar R, Logan GD, Tannock R. 1999. Development of inhibitory control across the life span. *Developmental Psychology* 35:205–213.

Table 1. Descriptive statistics by condition for age, baseline mood and deprivation score.

	Negative	Neutral	Condition difference
Participants	30 (18 female)	28 (20 female)	
Age (years)	*M* = 34.8, *SD* = 15.9	*M* = 30.5, *SD* = 13.3	$t_{55} = 1.09$, p = 0.28
Baseline Mood (1 - 100)	*M* = 80.4, *SD* = 17.9	*M* = 71.7, *SD* = 22.6	$t_{56} = 1.62$, p = 0.11
Deprivation Score (0 - 1)	*M* = 0.45, *SD* = 0.29	*M* = 0.45, *SD* = 0.25	$t_{55} = 0.09$, p = 0.93

Table 2. Summary of general linear models predicting GRT (upper rows) and SSRT (lower rows)

Variable	Parameter estimate	Standard error	t	p
Outcome variable: GRT				
Age	4.85	1.35	3.59	0.01
Deprivation score	185.20	225.82	0.82	0.42
Baseline mood	0.46	0.98	0.47	0.64
Condition	8.39	76.27	0.11	0.91
Deprivation score * condition	-117.44	150.16	-0.78	0.44
Outcome variable: SSRT				
GRT	-0.08	0.04	-2.15	0.04
Age	1.08	0.41	2.63	0.01
Deprivation score	146.65	61.83	2.37	0.02
Baseline mood	-0.40	0.27	-1.50	0.14
Condition	18.40	20.75	0.89	0.38
Deprivation score * condition	-65.26	41.09	-1.59	0.12

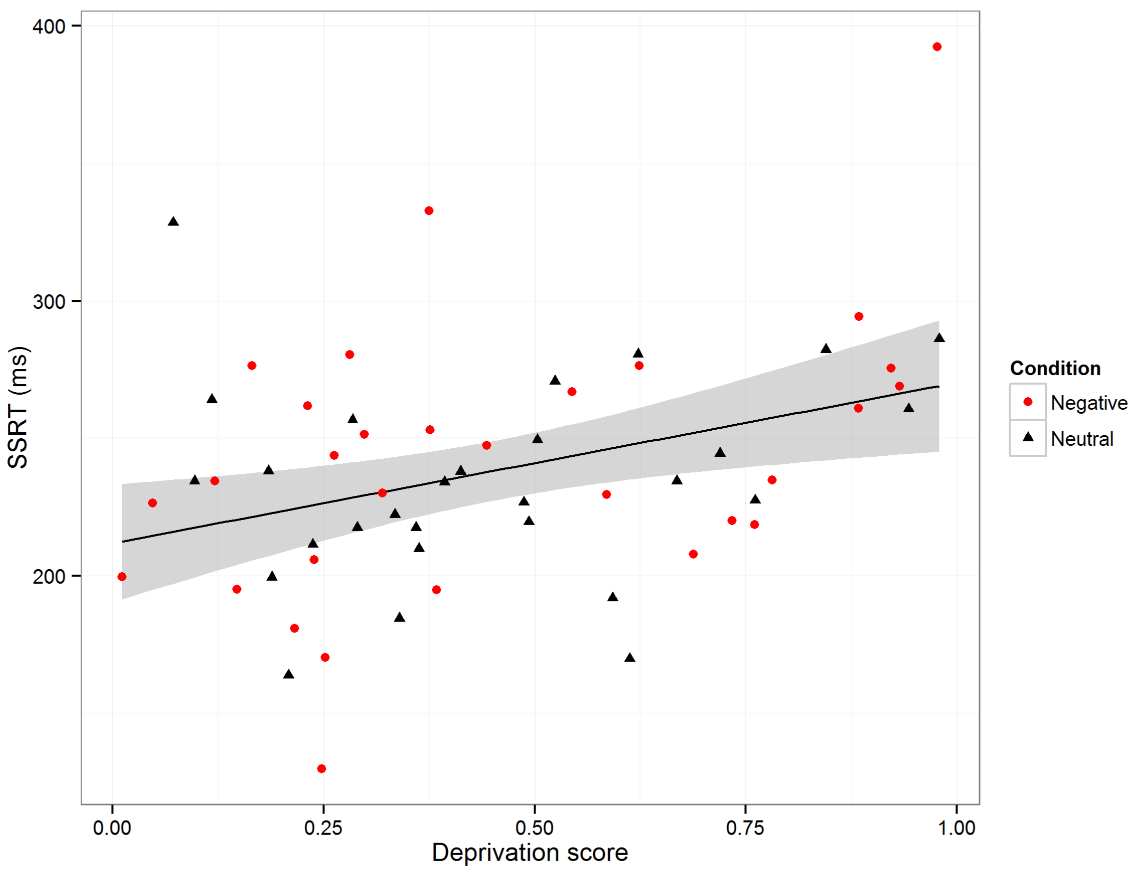

Figure 1. Scatterplot of stop-signal reaction time (SSRT) against deprivation score, with participants labelled by condition in the mood manipulation.