Impulsivity, Sensation Seeking and Reproductive Behaviour: A Life History Perspective.

Abstract

Impulsivity has often been invoked as a proximate driver of different life-history strategies. However, conceptualizations of "impulsivity" are inconsistent and ambiguities exist regarding which facets of impulsivity are actually involved in the canalisation of reproductive strategies. Two variables commonly used to represent impulsivity were examined in relation to reproductive behaviour. Results demonstrated that sensation seeking was significantly related to strategy-based behaviour, but impulsivity (defined as a failure to deliberate) was only weakly correlated. The effect of impulsivity disappeared when sensation seeking was controlled. Sex differences emerged for sensation seeking but not impulsivity. We conclude that "impulsivity" is not a unitary trait and that clearer distinctions should be made between facets of this construct.

Keywords: Life History, Reproduction, Impulsivity, Evolution, Sensation Seeking

1. Introduction

Life History Theory (LH) proposes (and data confirm) that behaviours cluster together, forming predictable adaptive strategies contingent on experiencing environmental (un)certainty during development (Belsky, Steinberg, & Draper, 1991; Chisholm, 1999). Research also links LHT to individual differences in personality, particularly "impulsivity". This study sought to investigate how "impulsivity" relates to LHT strategy in more detail on a large non-clinical population.

1.1 Impulsivity

Impulsivity is commonly defined as a "tendency to act spontaneously and without deliberation" (Carver, 2005, p.313). Conceptualizations of "impulsivity" vary tremendously, with Depue and Collins (1999, p.495) claiming it "comprises a heterogeneous cluster of lower order traits" including sensation seeking (Zuckerman, 1971), delay discounting (Mazur, 1987), venturesomeness (Eysenck & Eysenck, 1985) and lack of perseverance (Whiteside & Lynam, 2001), to name but a few (see Evenden, 1999). Many authors stress the multidimensional nature of impulsivity (e.g. Carrillo-de-la-Pena, Otero, & Romero, 1993; Whiteside & Lynam, 2001). Others note important conceptual differences between "impulsivity" constructs (Evenden, 1999; Cross, Copping & Campbell, 2011), whilst research demonstrates that different "impulsivity" traits have different effects on behaviours (Derefinko, DeWall, Metze, Walsh, & Lynam, 2011). Other conceptual ambiguities also exist. Is "impulsivity" part of a higher order cognitive process (e.g. executive control) or is it a lower order trait contingent on affective motivation (Carver, 2005; Evans, 2008)? A variety of measures have been developed to investigate "impulsivity" constructs. However, studies indicate that self-report measures and behavioural measures do not correlate significantly and that measures may tap different functions (Carillo-de-la-Pena, et al., 1993; Reynolds, Ortengren, Richards, & de Wit, 2006). Precisely what is being measured in studies investigating "impulsivity" can therefore be ambiguous.

1.2 Life History Theory

LH theory suggests that resources in developmental environments are finite, forcing organisms to make allocation decisions that maximise fitness potential (see Kaplan & Gangestad, 2005). This creates trade-offs; an organism can spend more time maturing at the expense of reproductive lifespan, or shorten development and reproduce earlier at the expense of offspring quality. Research indicates that reproductive behaviours form part of a strategy calibrated to local environmental conditions. An individual in an uncertain environment will mature earlier, initiate sexual activity earlier and mate more frequently with multiple sexual partners (adopting a fast LH tempo). Fast strategists exhibit a host of other traits including, higher levels of aggression, a tendency to have more children, a shorter lifespan, lower IQ scores and more mental health problems (Chisholm, 1999; Ellis, 1988; Rushton, 1995). Those developing in stable, predictable environments exhibit the opposite pattern of behaviour (adopting a slow LH tempo).

Many behaviours associated with LH strategies express sex differences. There are consistent cross-cultural sex differences in levels of aggression, with men universally being more aggressive (Archer, 2009; Bettencourt & Miller, 1996). Levels of mating-related behaviour, such as higher scores on the Sociosexuality Inventory, more energy expended on mating rather than parenting and stronger preferences for short term mating also show significant differences in the male direction (Buss & Schmitt, 1993; Jackson & Kirkpatrick, 2007; Penke & Asendorpf, 2008). These sex differences emerged due to differences in fitness variance exhibited by the sexes (Bateman, 1948) and evolved via sexual selection to enhance success in the competition for the survival of genetic lineages. A review by Ellis (1989) suggests that males exhibit more behaviour consistent with faster strategies than females due to androgen exposure.

1.3 Life History and Impulsivity

As behaviours are sensitive to environmental factors, a proximate mechanism that responds to changes in levels of certainty must exist. Proposals drawing upon various conceptualisations of "impulsivity" have been made. Chisholm (1999, p.135) claimed that strategy development was guided by an individual's "time preference", an economic term encompassing multiple traits including "intertemporal choice [between alternatives with varying costs or benefits over time], impatience, impulsiveness, self-control and the inability to defer gratification". Figueredo et al. (2005) focused on risk taking and impulsivity measures which correlated negatively with a measure of slow LH strategy (mini K) and impulse control which correlated positively with the "K Factor". Hill, Jenkins and Farmer (2008) examined future discounting which partially mediated the relationship between uncertain family environments and risk taking behaviours. Previous research therefore implicates some form of "impulsivity" in strategy formation. Like LH behaviours discussed earlier, many "impulsivity" traits also show consistent sex differences. Sensation seeking (Cross, et al., 2011; Wilson & Scarpa, 2010), dysfunctional impulsivity (Cross et al., 2011) and risk taking measures (Byrnes, Miller & Schafer, 1999) indicate that men engage in more thrill seeking activities and take more risks than women. This suggests that sex differences in LH tempo may therefore be associated with sex differences in "impulsivity" traits.

Key questions remain however. Which particular traits are important and how do they relate to strategies? Do all "impulsivity" conceptualizations contribute uniquely and additively to the development of strategy-based behaviour or do some conceptualizations subsume others? Frederick, Loewenstein and O'Donoghue (2002) concluded that 'time preference' is unlikely to be a unitary construct due to weak correlations between different measures and behavioural indicators. Loewenstein, Weber, Flory, Manuck and Muldoon (2001) suggested instead that time preference is multi-dimensional with three constituent facets: impulsivity (spontaneous and unplanned activity), compulsivity (careful planning) and inhibition (restricting impulsive behaviour). A crucial objective in LH research should be to identify which traits are actually predictive of LH behaviours before endorsing them as proximate psychological mechanisms driving LH trajectories. This is the aim of the current study.

In this study, two measures of "impulsivity" were examined to determine which better predicts LH strategy; impulsivity and sensation seeking. These were selected because an analysis by

Cross et al. (2011) indicates that they are likely to be distinct traits. This study defines "impulsivity" as a failure of deliberation measured by items including "I often do things on impulse" and (reverse-scored) "I usually think about what I am going to do before doing it" (Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993). Impulsivity has been conceptualised in terms of a dual process model in which it represents inefficient higher-level inhibitory control over lower-level affective drive states. McDonald (2008) suggests that, for evolutionary reasons, males demonstrate a weaker ability to inhibit affective impulses than women. Neuroimaging studies indicate that affective activation in the amygdala is modulated by the orbitofrontal cortex (Wager, Davidson, Hughes, Lindquist, & Ochsner, 2008) and that testosterone attenuates orbitofrontal-amygdala connectivity (van Wingen, Mattern, Verkes, Buitelaar, & Fernandez, 2010; Volman, Toni, Verhagen, & Roelofs, 2011) reducing modulation of affective impulses. Sensation seeking focuses on desire for thrill and excitement, including items such as "I like to have new and exciting experiences and sensations even if they are a little frightening" and "I enjoy getting into new situations where you can't predict how things will turn out". In terms of dual process models, sensation seeking is thought to be a manifestation of lower-level affective and motivational systems governing approach behaviour.

This study asks whether LH decisions favouring a faster LH strategy are linked with deliberative failure, the pursuit of sensation or both. We aim to clarify which "impulsivity" conceptualisation is most closely associated with key life history milestones. Sex differences in strategy-based behaviours should also be reflected in any candidate "impulsivity" measures. In their meta-analysis, Cross et al. (2011) concluded that, whilst consistent and significant sex differences emerged in the domain of sensation seeking, impulsivity measures show weak or no sex differences. It is predicted that these findings will be replicated.

2. Method

2.1 Participants and data collection

Seven hundred and sixty one British adults were recruited via an independent marketing company to participate in an online questionnaire. Four hundred and nine participants were male (mean age = 40.47, SD = 8.62) and 352 were female (mean age = 37.94, SD = 8.77). Occupation was recorded via social grade categories: 49.9% A&B (high and intermediate managerial and professional), 39.9& C1 & C2 (clerical, administrative and skilled manual) and 6.7% (unskilled & unemployed), 3.5% unspecified. This is somewhat higher than the national average. No significant differences were found between these groups in variables examined in this study and occupation was discounted from further analyses. Participants were not remunerated for participation.

2.2 Measures

Impulsivity (*Imp*) and Sensation Seeking (*SS*) were measured using the Impulsive-Sensation Seeking sub-scale of the ZKPQ (*Imp-SS*, Zuckerman et al., 1993), a 19-item measure that consists of 11 sensation seeking and eight impulsivity items. The scale was designed to measure impulsivity and sensation seeking as part of a superordinate trait (Zuckerman, 1994) but factor analysis demonstrates that it splits into two distinct subscales (Zuckerman & Kuhlman, 1993). Responses are recorded in a binary true or false format. Subscale alphas were high: .82 for *SS* and .73 for *Imp*.

Participants were asked questions aimed at assessing reproductive strategy. These variables were theoretically appropriate given the focus of LH on accelerated reproductive schedules (see Belsky et al., 1991; Chisholm, 1999). The measures were: *Age of Puberty Category*: Participants were asked to indicate how old they were when they reached puberty, categorised on a Likert scale graded as (1), age 11 or earlier, (2), age 12, (3), age 13, (4), age 14, (5), age 15 and (6), age 16 or above. *Age of First Sex*: Participants were asked to specify at what age they first had sexual intercourse. *Number of Sexual Partners*: Participants were asked to indicate how many people they had had sexual intercourse with in their lifetime, categorised on a scale graded as (1) 0, (2), 1, (3) between 2 and 10, (4) between 11 and 20, (5), between 21 and 50, (6), between 51 and 100, (7) more than 100. This was adjusted to control for participant age by creating a new variable called *Rate of Partners*; calculated by subtracting *Age of Puberty Category* from chronological age to give an indication of reproductive lifespan to date in years. *Number of Sexual Partners* was then divided by reproductive lifespan to give an indication of the rate of partners per year. As *Number of Sexual*

Partners is categorical, the lower bound number in each category was used for the basis of calculation.

Correlation analysis was conducted using IBM Statistics SPPS (Version 19). Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM) were performed using AMOS (Version 19) and EQS (Version 6.1).

3. Results

Descriptive statistics are provided in Table 1 for all variables. CFA was used to determine the best measurement model for the *Imp-SS* scale. A unitary construct was compared to a model with two separate, correlated factors, representing the distinction between *SS* and *Imp*. Models were compared using a variety of fit statistics. Chi-square tests evaluate the significance of differences between the restricted and unrestricted sample covariance matrix. The CFI (Comparative Fit Index) compares the similarities between the model's covariance matrix and the matrix observed in the data. The Root Mean Square Error of Approximation (RMSEA) examines overall model complexity. CFI values should be greater than .90 and RMSEA values should ideally be lower than .10 (Bentler & Bonett, 1980; Steiger, 1989). Table 2 represents fit statistics for both models and illustrates that a two factor solution fits more parsimoniously and is a significantly better model (X^2diff = 393.86, df diff = 1, p<.001). While seemingly clear that the two factor solution is better, fit statistics from maximum likelihood estimation were disappointing. It is important to recognise, however, that maximum likelihood estimation underestimates model fit when the model contains categorical variables (Bentler, 2005). The *Imp-SS* Scale is scored on an ordered categorical system, and so the current fit statistics will be an underestimate. Bentler (2005) argued that the best approach to this problem is to correct the test statistic while still using ML estimation. It has been shown that using ML and making Satorra-Bentler (1988) corrections yields reliable results (Di Stefano, 2002). In order to provide appropriate fit statistics, data was re-analyzed using EQS6 (Bentler & Wu, 2002), which calculates the Satorra-Bentler corrections. From these statistics (Table 2), it is not only clear that a two factor model is a better fit but also that this represents an acceptable fit to the data from both the RMSEA and CFI. Accordingly, *Imp* and *SS* are treated as separate entities for further analysis.

Correlations between variables within this study are presented in Table 3. Intercorrelations between variables are as predicted by LH, with *Age of First Sex* correlating negatively with *Rate of Partners* and positively with *Age of Puberty Category*. *SS* and *Imp* are significantly correlated, r = .52. *Imp* and *SS* are also correlated significantly with *Age of First Sex* and *Rate of Partners*, correlations being stronger for *SS* than for *Imp* in both cases. The directions of relationships are also as predicted (with *Age of First Sex* decreasing and *Rate of Partners* increasing with increases in *SS* and *Imp*). The relationship between *Age of Puberty Category* and both *Imp and SS* is non-significant.

Males reported significantly higher rates of sexual partners than females (t(759) = -3.73, p = <.001). Females reached puberty significantly earlier on average than males (t(759) = -4.89, p=<.001). There was a significant sex difference for *SS* (t(759) = -3.06, p = <.01), but not for *Imp* (p > .05).

SEM was used to individually and simultaneously examine the independent effects of *SS* and *Imp* on LH variables to determine if contributed variances were unique. Models were specified by directly linking *Age of Puberty Category* to *Age of First Sex* and *Age of First Sex* to *Rate of Partners*. *Imp* and *SS* variables were then directly linked to *Age of First Sex* and *Rate of Partners*. Table 4 illustrates fit statistics for these models. Only the *SS* model meets the criteria for a good fit to the data and is significantly better than both the *Imp* model (X^2diff = 83.33, df diff = 33, p < .001) and the combined model (X^2diff = 576.08, df diff = 131, p < .001). The *Imp* model shows the least acceptable fit to the data, failing on all key indicators. *Imp* and *SS* models differ in terms of their relationship to LH variables. In the *SS* model, the relationships between *SS* and *Age of First Sex* and *Rate of Partners* are significant (p < .001), with β = -.21 and β = .18 respectively. R^2 values for these relationships are .11 and .08 respectively. Relationships between *Imp* and the two LH variables are weaker, with β = -.11 and β = .11 respectively and are non-significant (p > .01). R^2 values for these relationships are .08 and .06 respectively.

When examined simultaneously, the beta weight strengths between the two impulsivity measures (controlling for their intercorrelation) and the LH indicators change considerably. The relationships between *SS, Age of First Sex* and *Rate of Partners* increase to β = -.27 and β = .19 respectively and are significant ($p < .001$). The relationship between *Imp* and the same variables however diminish considerably to only β = .08 and β = -.01 respectively. Both links are non-significant ($p > .05$). This suggests that *SS* subsumes the contribution of *Imp* in relation to LH variables and that *Imp* contributes no significant unique variance. R^2 values for these relationships are .11 and .08 respectively.

4. Discussion

The data indicate that sensation seeking is more closely related to LH traits than impulsivity. Sensation seeking is more predictive of outcome measures, shows stronger correlations with LH traits, subsumes contributed variance of impulsivity and demonstrates expected patterns of sex differences.

The greater importance of sensation seeking relative to impulsivity likely derives from differences in conceptualisation and the associated underlying psychological processes they assess. Measures of general “impulsivity” focus on lack of deliberation and planning failure. Sensation Seeking is distinct from these and makes no reference to acting without forethought. Zuckerman (1994) acknowledges that sensation seekers do not fail to plan (parachutists do not impulsively leave an aircraft without planning and preparation). Sensation seeking reflects affective motivation and increased appetite for risk. This link to affective risk taking likely makes sensation seeking more relevant to LH strategy than impulsivity. Those developing in harsh, uncertain environments must take more risks to secure their genetic lineage whether through an appetite for earlier, frequent reproductions with multiple partners or through risky resource competition with others. Measures gauging attraction to risk taking (such as sensation seeking) are therefore more likely to be predictive of LH tempo.

Sensation seeking and impulsivity differ in another important way; the relative importance of affective and cognitive processes. Impulsivity, as measured in this study, employs general items about planning that tap cognitive control of behaviour, whereas sensation seeking assesses affective attraction to risk. In dual process models, these two domains correspond to the distinction between reflective 'cold' processing (higher-order, analytic, controlled) and reflexive 'hot' processing, (lower-order, affective, motivational). The former system is seen as a uniquely human capability, while the second is evolutionarily older and shared with other species (Carver, 2005; Evans, 2008; MacDonald, 2008). It may therefore be that impulsivity items that assess deliberative failure (lacking affective elements) tap higher-level "cold" cognitive processes and, more importantly, that these are less central to LH behaviours than more ancient affective systems. Factor analytic studies confirm that impulsivity items (focusing on effortful deliberation) do not load on the same factor as measures of reward or incentive sensitivity associated with the reflexive system (Clark & Watson, 1999; Depue & Collins, 1999; Zelenski & Larsen, 1999). In their meta-analysis, Cross et al., found no sex differences on effortful control measures (including failure to deliberate) although men exceeded women on affectively-loaded sensation-seeking and risk-taking measures.

Sex differences in sensation seeking have been explained in relation to evolutionary theory. Wilson and Daly (1985) suggest that asymmetries in parenting effort constrain males to take more risks in pursuit of reproductive success. As such, males develop a "taste for risk", manifested across multiple domains, demonstrating fearlessness and survivorship that makes them attractive as mates whilst depriving other males of resources. Campbell (1999) suggests this is complemented by an evolved female propensity to avoid risk; infants are strongly dependent on maternal investment and women should avoid risks that might threaten their survival or wellbeing. Research shows that sex differences in risk taking increase in line with potential costs (Byrnes et al., 1999). Impulsivity items on the inventory employed in this study do not allude to risk and so sex differences would not be predicted to emerge. However sensation seeking items do and here sex differences are found. In summary, impulsivity as a failure to deliberate bears only a weak association with both sex differences and associated LH strategy.

This study supports the idea that a global construct of “impulsivity” or “time preference” may not be useful in understanding LH strategy development. Rather, the evidence presented here suggests that sensation seeking and deliberative failure emerge as distinct (although correlated) traits with different impacts on LH behaviour. Combined with previous evidence of distinct subscales in the *Imp-SS* (Zuckerman & Kuhlman, 1993), differences in the magnitude of sex differences found in measures subsumed under the umbrella concept of ‘impulsivity’ (Cross et al., 2011), and the consistent demonstrations that sensation seeking items cluster together with only weak associations with impulsivity items (e.g. Depue & Collins, 1999), the argument for distinct constructs is compelling.

In LH theory, there is currently a lack of unanimity about the nature and role of “impulsivity” mechanisms. Chisholm emphasises the attraction of immediate reward over delayed returns (hinting at affective motives to behaviour). However, research on the traits comprising “time preference” (inter-temporal choice, delay of gratification etc.) tend to employ cognitive or emotionally neutral items (see Cross et al., 2011). Other LH studies offer different conceptualizations. For instance, impulse control is deemed important to Figueredo et al.’s (2005) K-Factor, but its precise role (whether as a cause or a correlate of LH traits) is not specified. Hill et al. (2008) identify sensation seeking (a proxy for temperamental vulnerability) as an indirect cause of weak future orientation which in turn gives rise to risk taking (comprised of “impulsivity” operationalized as loss of control and risky behaviour). In these three studies alone “impulsivity” traits are used as a global cause, a LH correlate, a behavioural outcome, a mediating mechanism and a biological vulnerability. Whilst it is clear that “impulsivity” constructs are involved in the development of LH strategies, their precise influence remains ill-defined in the evolutionary literature.

4.1 Limitations and conclusions

This study examined only two types of “impulsivity”. Further work is needed to provide greater clarity regarding the many ‘hot’ and ‘cold’ facets of impulsivity from a LH strategy perspective. The variance explained by traits in the present study is small (ranging from six to eleven percent). It is feasible that another “impulsivity” trait is a better predictor of LH strategy. Although we found that the additive effect of these variables was no better than sensation seeking alone, different combinations of traits may produce different results. In addition to additive effects, future work could examine further the temporal order of their relationship over the course of childhood strategy development (Hill et al. 2008).

It is clear that sensation seeking and impulsivity are distinct entities (both conceptually and empirically) and are probably subserved by different psychological processes. Caution should be employed when using umbrella terms such as “impulsivity” because researchers make different assumptions about its meaning and employ very different (and often uncorrelated) measures. Future research would benefit from making more sensitive distinctions between related concepts (and measures) of impulsivity which may be associated with very different behavioural outcomes.

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Table 1

Means (and standard deviations) for all measures (N = 761)

Measure	Whole sample	Males	Females
Impulsive Sensation Seeking	8.46 (4.66)	8.74 (4.44)	8.13 (4.90)
Impulsivity	2.53 (2.12	2.48(2.06)	2.58 (2.19)
Sensation Seeking	5.92 (3.19)	6.25(3.08)	5.55 (3.29)
Age of Puberty Category	3.12 (1.31)	3.33 (1.24)	2.88 (1.33)
Age of First Sex	17.92 (3.19)	17.95 (3.35)	17.89 (3.01)
Rate of Partners	0.37 (0.73)	0.46 (0.87)	0.27 (0.52)

Table 2

Factor solution fit statistics (N=761)

Model	X^2	**DF**	X^2**/DF**	**RMSEA**	**C.I.**	**CFI**
Unitary	1042.18	152	6.86	.088	.08/.09	.75
Unitary*	959.83	152	6.28	.084	.08/.09	.78
Two Factor	648.32	151	4.29	.066	.06/.07	.79
Two Factor*	540.23	151	3.58	.058	.05/.06	.95

*Satorra-Bentler correction applied

Table 3

Correlations of all variables (N=761)

	Impulsivity	Sensation Seeking	Puberty	Sex
Sensation Seeking	.52**			
Age of Puberty Category	-.04	-.04		
Sex	-.10**	-.20**	.26**	
Rate of Partners	.09*	.20**	-.02	-.22**

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

Table 4

Model comparisons (N=761)

Model	X^2	DF	X^2/DF	RMSEA	C.I	CFI	R^2 (Sex)	R^2 (Rate of Partners)
Imp-LH	377.83	43	8.79	.101	.10/.11	.74	.08	.06
SS - LH	294.50	76	3.88	.062	.05/.07	.90	.11	.08
Combined	870.58	205	4.24	.065	.06/.07	.82	.11	.08

*P<.001