Genetic and Environmental Influences on Gambling Disorder Liability: A Replication and Combined Analysis of Two Twin Studies

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BACKGROUND

- Gambling disorder (GD) is an addictive disorder characterized by having difficulty limiting money or time spent on gambling; this leads to adverse consequences for the gambler as well as people in the gambler's social network and the larger community.

- GD is the first "behavioral addiction" to be included in the DSM, and has recently been re-classified in the DSM-5 as belonging to the same category as the substance use disorders. This was based on emerging evidence of shared neurobiological underpinnings and phenomenology. In contrast to substance use disorders, however, there has been relatively little research examining contributions of genetic and environmental influences to the risk for GD.

- Worldwide estimates of the past-year prevalence of GD range from 0.2% to 5.3%; the lifetime prevalence of GD in the US is less than 1% (Hodgins et al, 2011). Australia is an ideal location to conduct research on genetic and environmental influences on gambling disorder, as it has one of the highest rates of gambling and gambling disorder in the world (Slutske et al, 2009).

THE PRESENT STUDY

- The present study represents an attempt to replicate the results of a previous twin study (Slutske et al., 2010) in a new independent Australian twin cohort.

- We conducted a more powerful analysis by combining the data from the original twin study with the new Australian twin cohort. This combined analysis will represent the largest twin study of GD conducted to date.

METHODS

Participants:
- Replication Study:
  - 3,292 members of the Australian Twin Registry Cohort III.
  - Twins were born between 1972 and 1979, with a mean age of 31.8 years old (range 27-40).
  - 64% female
- Original Study:
  - 4,764 members of the Australian Twin Registry Cohort II
  - Twins were born between 1964 and 1971, with a mean age of 37.7 years (range 32 -43).
  - 57% female

Measures:
- Gambling disorder: The NORC DSM-IV Screen for Gambling Problems (NODS; Gerstein et al., 1999) was used to assess GD. Test-retest reliability of the DSM-5 GD measure in the original cohort was very good (kappa = .75, Yule's Y = .82; Slutske et al., 2013).

Data Analysis:
- Biometric models were fit by the method of robust weighted least squares using the Mplus program (Muthén & Muthén, 2017) including data from incomplete as well as complete twin pairs. Liability threshold models were fit to the twin data. Biometric model fitting was conducted to partition the variation in GD liability into additive genetic, shared environmental or nonadditive genetic, and unique environmental influences.
  - Analyses were first conducted in the replication sample using a broad GD threshold of 1 or more symptoms.
  - When the replication and original samples were combined, four different thresholds were examined 1 or more, 2 or more, 3 or more, and 4 or more symptoms of GD (the latter consistent with the DSM-5 GD diagnosis), as well as a 3-level multiple-threshold diagnosis.

RESULTS

Table 1. Lifetime prevalence of gambling involvement and gambling disorder among 8,056 adult Australian twins from two independent cohorts.

	Cohort II (Original Study)			Cohort III (Replication Study)		
	Full sample	Men	Women	Full sample	Men	Women
Lifetime gambling involvement, ever gambled…						
…5x/year	77.4%	81.3%	74.5%	49.6%	65.3%	41.2%
…weekly[a]	36.0%	39.1%	33.7%	11.1%	18.6%	7.0%
Gambling disorder at four different symptom thresholds						
4+ symptoms[b]	2.8%	4.2%	1.7%	2.1%	4.1%	1.0%
3+ symptoms	3.8%	5.8%	2.4%	2.8%	5.5%	1.4%
2+ symptoms	5.7%	8.7%	3.5%	4.0%	7.6%	2.2%
1+ symptoms	12.5%	18.2%	8.3%	7.8%	14.3%	4.3%

Note: [a] ever gambled at least one a week for at least six months in a row; [b]corresponds to a DSM-5 diagnosis of gambling disorder.

Twin Correlations:

**Table 2. Twin correlations in liability for gambling disorder[a].**

	Cohort II	Cohort III
MZ male	0.49 (0.31 – 0.67)	0.40 (0.12 - 0.69)
DZ male-male	0.27 (0.01 – 0.52)	0.20 (0.06 - 0.35)
MZ female	0.53 (0.32 – 0.73)	0.69 (0.50 - 0.88)
DZ female-female	0.22 (-0.09 – 0.53)	0.35 (0.25 - 0.44)
DZ male-female	0.23 (0.02 – 0.45)	0.05 (-0.47 - 0.56)

Note: Cell entries are tetrachoric correlations; 95% confidence intervals are in parentheses. [a] using a threshold of 1+ gambling disorder symptoms

Biometric Model Fitting:
- Replication Sample:
  - The best fitting model was one that included additive genetic and unique environmental sources of variation—shared environmental factors did not account for a significant portion of the variability in liability for GD.
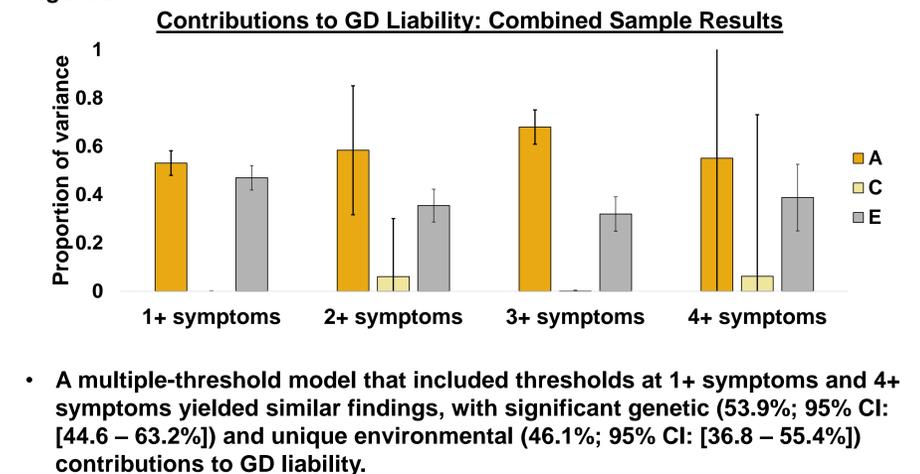
Figure 1.

Contributions to GD Liability: Replication Sample Results
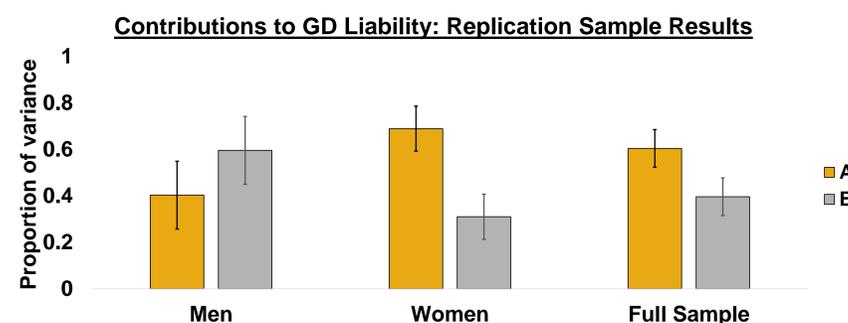
- Combined sample:
  - With the increased power from the combined sample, analyses were conducted examining influences on higher levels of GD symptomatology, including a threshold of four or more symptoms, which is consistent with the DSM-5 GD diagnosis.

RESULTS (continued)

Figure 2.

Contributions to GD Liability: Combined Sample Results

- A multiple-threshold model that included thresholds at 1+ symptoms and 4+ symptoms yielded similar findings, with significant genetic (53.9%; 95% CI: [44.6 – 63.2%]) and unique environmental (46.1%; 95% CI: [36.8 – 55.4%]) contributions to GD liability.

DISCUSSION

- The findings of a previous Australian twin study (Slutske et al., 2009) were replicated in an independent Australian twin cohort. There was evidence for significant genetic (60%) and unique environmental (40%) contributions to GD liability.

- In both the original and the replication samples, there was no evidence for a significant effect of the shared environment or for sex differences in GD liability.

- Despite the lack of significant sex differences, it might be premature to rule out the possibility of differences between men and women in the genetics of GD. Men and women differ in the types of gambling they participate in and differ in their performance on a gambling task that is related to neurobiological differences (Savage et al., 2014; van den Bos et al., 2013).

- Despite the finding that shared environmental influences did not contribute significantly to GD liability, there are likely to be many genetically-contingent environmental effects for GD.

- Given consistent evidence from twin studies demonstrating an important aggregate influence of genetic factors in the risk for GD among men and women, a major challenge ahead will be to identify the specific individual genetic variants that confer this risk.

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