Supplemental Materials

Local Area Disadvantage and Gambling Involvement and Disorder: Evidence for Gene-Environment Correlation and Interaction

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Table S5. The density of electronic gambling machines (outside of casinos) for the eight different states or territories in Australia and the associations between local area disadvantage and gambling involvement and disorder within each state.

1) The SEIFA Index of Relative Disadvantage measure.

The Index of Relative Disadvantage (IRSD) is one of a suite of four indexes created by the Australian Bureau of Statistics (ABS) based on socioeconomic variables culled from the 2006 Census of Population and Housing. The SEIFA indexes have been used in their present form since 1986, and are updated every five years subsequent to each new Australian census.

Based on international research and the information collected in the Census, the construct of relative socio-economic disadvantage was defined in terms of "people's access to material and social resources, and their ability to participate in society." It was based on variables from the following broad dimensions: income, education, employment, occupation, housing, and other indicators of relative disadvantage. An external group of experts reviewed the variables used in SEIFA 2006. After removing redundant variables that were highly correlated, an initial principal components analysis of 20 selected variables was conducted and variables with factor loadings of below |.30| were excluded. This resulted in the dropping of 3 items. The final principal components analysis yielded a factor with an eigenvalue of 6.62 that explained 39% of the variance of the 17 variables. A number of methods were used by the ABS to validate the IRSD.

The IRSD is the most widely used of the four SEIFA indexes and has become the de facto standard as a socioeconomic index in Australian public health research. The IRSD from the previous 2001 SEIFA was extensively validated against self-report measures in a representative survey of adults residing in the state of South Australia in 2002 (Dal Grande et al., 2004). In particular, those living in the most disadvantaged areas, based on the IRSD score that was associated with their postal code, characterized their neighborhoods as being lower in social capital. Individuals living in the top two highest quintiles of area disadvantage were significantly less likely to report that their neighborhood was a safe place to live and that they felt safe in their

own home. Individuals in the top quintile of area disadvantage were significantly less likely to report that people in their neighborhood generally trusted each other. Parents in the top quintile of area disadvantage were significantly more likely to report that they had problems with transport when wanting to go, for example, to the hospital, medical appointments, recreational facilities, visiting people, shopping, school or childcare.

Table S1
Distribution of Postal Code Areas by Levels of Disadvantage for the Entire Australian Population and Among the Present Study Sample

Disadvantage	Australian population		Present sample	
Decile	Frequency	Percent	Frequency	Percent
10 (high)	247	10.0	74	5.8
9	248	10.0	96	7.5
8	248	10.0	104	8.1
7	248	10.0	125	9.8
6	248	10.0	117	9.2
5	248	10.0	123	9.6
4	248	10.0	131	10.3
3	248	10.0	153	12.0
2	248	10.0	168	13.1
1 (low)	247	10.0	187	14.6
Total	2478	100.0	1278	100.0

Table S2
Distribution of Specific Disadvantage Indicators by SEIFA IRSD Decile for the Postal Code Areas Represented in the Study Sample

Decile	% no internet	% labourers	% income between $13,000 - $20,799
10 (high)	48.55	14.97	12.46
9	46.06	13.02	13.07
8	43.68	12.39	12.69
7	41.51	11.25	12.34
6	38.71	10.45	11.49
5	36.66	9.62	10.97
4	32.86	8.34	10.28
3	29.99	7.34	9.76
2	26.05	5.51	8.88
1 (low)	20.08	3.71	7.64
Overall	34.23	8.82	10.55

2) Derivation of the disordered gambling factor.

A two-stage process was used in the derivation of the disordered gambling factor. The first stage was an exploratory factor analysis of 9 DSM-5 disordered gambling symptoms, 15 of the 20 items from the SOGS (five of the SOGS items had to be omitted because they were endorsed by only 0-2 participants), and an additional item related to the versatility of gambling involvement. One- through four-factor models were fit to the data.

Table S3
Results of Exploratory Factor Analysis of Disordered Gambling Indicators

# factors	RMSEA	CFI	TLI	χ^2	df
1	0.013	0.986	0.985	511.456	275
2	0.007	0.997	0.996	309.558	251
3	0.005	0.998	0.998	258.046	228
4	0.003	0.999	0.999	216.046	206

Note: RMSEA = root mean square error of approximation, CFI = comparative fit index, TLI = Tucker-Lewis Index.

The one-factor model provided an excellent fit to the data (RMSEA = 0.01) and the scree plot was also strongly consistent with a one-factor model.

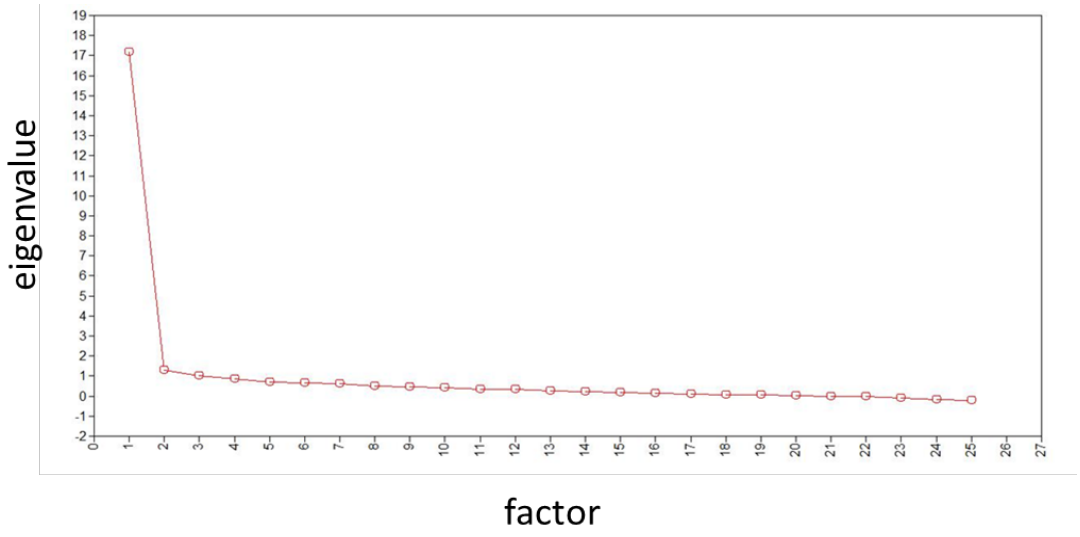

Figure S1. Scree plot from an exploratory factor analysis of 25 disordered gambling indicators.

2) Derivation of the disordered gambling factor, continued.

Examination of the factor loadings from the 2–4 factor models did not reveal any coherent pattern consistent with multiple factors. For example, there was not a 'DSM' versus 'SOGS' factor. All of the items strongly and positively loaded on the first factor in the 2-4 factor models, and the loadings on the additional factors were generally low and/or negative.

Based on the results of the exploratory factor analysis, a confirmatory factor analysis with a single factor was conducted in the second stage of the derivation of the disordered gambling factor. A confirmatory factor analysis allowed us to properly account for the clustering in the data and to examine and present the item thresholds.

3) An alternate biometric model to test gene-environment interaction.

Method. The significant gene-environment interaction results were probed further by fitting the data to the model depicted in Figure S2. In this model the *ac*' and *ec*' parameters were dropped and the linear and quadratic main effects of local area disadvantage on the gambling outcome was represented by the paths *M* and M^2, respectively. This model isolated the paths *au* and *eu*, and a test of the significance of these two paths was provided by comparing the fit of this model to one in which the *au*' and *eu*' paths were set to zero.

Results. This alternate test strongly confirmed the presence of significant gene-environment interactions for electronic machine gambling among men (χ^2 = 6.98, df = 2, p = .03) and women (χ^2 = 25.35, df = 2, p < .0001), and for disordered gambling among women (χ^2 = 8.88, df = 2, p = .01). There was a trend for a significant interaction for disordered gambling among men (χ^2 = 5.64, df = 2, p = .06). Inspection of the parameter estimates from the model depicted in Figure S2 suggested that there was a significant environment-environment interaction (*au*' = -.09, *p* = .24; *eu*' = .13, *p* = .02; *M* = .09, *p* = .08, M^2 = .07, *p* = .16), that is, local area

disadvantage interacted with other latent sources of unique environmental risk for disordered gambling among men. Note that disordered gambling among men was the only instance in which there was a significant correlation with the unique environmental factors that contributed to variation in local area disadvantage (evidence for environment-environment correlation).

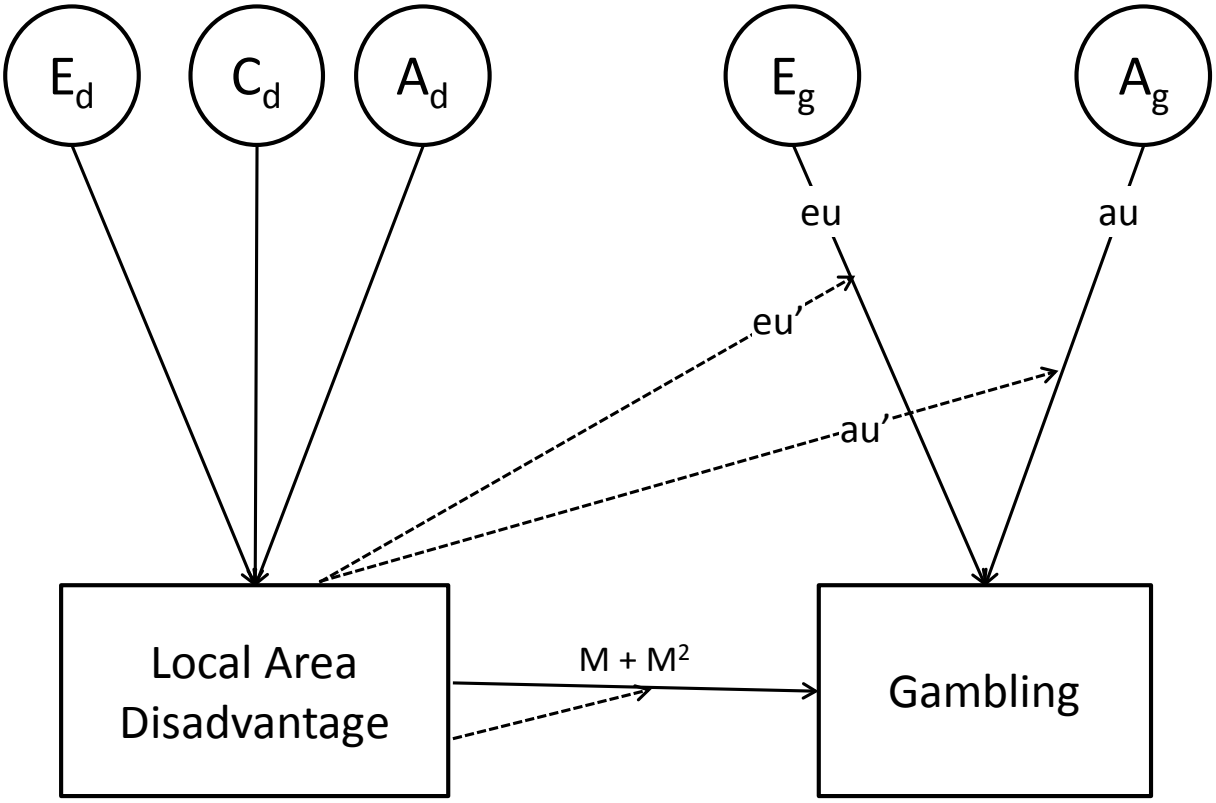

Figure S2. Alternate bivariate model (solid paths) in which the interactions involving genetic and environmental influences on local area disadvantage are replaced with the main and interaction ($M + M^2$) effects of local area disadvantage on gambling (any gambling, electronic machine gambling, or disordered gambling). The only G x E and E x E interaction effects (dashed paths) involve the unique variation in gambling that is not common to local area disadvantage. To simplify presentation, the model for only one twin from a pair is shown.

4) Table to accompany Figure 2 in the manuscript illustrating that the standard deviations as well as the means increased with increasing local area disadvantage.

Table S4
Mean Number of Days Gambled and Disordered Gambling in the Past Year by Level of Local Area Disadvantage

Local area disadvantage (decile)	N	Number of Days Gambled				Disordered gambling		
		Any Form		Electronic Machines		DG factor		DSM-5 DG diagnosis
		mean	SD	mean	SD	mean	SD	%
100% (most disadvantage)	181	53.73	72.34	15.50	32.38	0.34	0.85	3.3
90%	209	50.16	65.03	11.07	30.57	0.26	0.75	1.9
80%	284	45.60	62.94	6.94	20.58	0.19	0.71	2.5
70%	413	45.01	65.52	7.87	21.39	0.19	0.72	1.7
60%	453	41.92	56.18	5.30	14.89	0.14	0.67	0.7
50%	416	35.86	51.68	7.14	20.79	0.13	0.69	1.0
40%	478	41.17	58.21	6.94	25.55	0.15	0.65	0.4
30%	611	34.93	51.53	4.15	12.49	0.11	0.66	0.5
20%	744	31.64	44.87	4.24	16.44	0.06	0.61	0.5
10% (least disadvantage)	688	29.01	48.27	3.20	12.39	0.03	0.63	0.4
Full sample[a]	4,477	38.01	55.52	6.01	19.59	0.13	0.68	1.0

Note: DG = disordered gambling; means shown in the table are based on raw data to facilitate interpretation, analyses were conducted using log-transformed variables. [a] using data from participants with local area disadvantage data.

5) Probing the "active ingredient" in the effect of local area disadvantage on gambling involvement and disorder.

Table S5
The Density of Electronic Gambling Machines (Outside of Casinos) for the Eight Different States or Territories in Australia and the Associations Between Local Area Disadvantage and Gambling Involvement and Disorder Within Each State

State/territory	*n*	mean LAD decile[a]	Electronic gambling machine density				Correlation between LAD and…		
			venues[b]		machines[b]				
			number	per 10,000	number	per 10,000	any gambling	electronic machine gambling	disordered gambling
New South Wales	877	4.35	3,032	4.4	95,565	139.4	**.25**	**.22**	**.19**
Victoria	1,764	4.18	515	1.0	26,772	51.8	**.05**	**.13**	**.07**
Queensland	487	4.32	1,323	3.2	41,809	101.2	**.10**	**.11**	**.10**
South Australia	457	5.79	566	3.6	12,649	80.3	**.14**	**.24**	**.18**
Western Australia	647	4.11	0	0	0	0	.00	.03	.00
Tasmania	88	6.42	100	2.0	2,372	48.2	.18	**.22**	**.30**
Northern Territory	18	5.28	111	5.2	1,190	56.0	---	---	---
Australian Capital Territory	123	2.09	75	2.2	5,157	153.3	.15	**.19**	**.19**
Australia (all 8 states/territories)	4,477	4.37	5,722	2.7	185,514	89.0	**.10**	**.16**	**.11**
Australia (7 states/territories with venues)	3,815	4.42	5,722	3.1	185,514	98.8	**.12**	**.17**	**.12**

Note: [a] based on postal codes of the current sample, [b]obtained from Australian Productivity Commission Inquiry Report, 2010; EGM = electronic gambling machines, LAD = local area disadvantage, correlations in **bold** are statistically significant at $p < .05$

5) Probing the "active ingredient" in the effect of local area disadvantage on gambling involvement and disorder, continued.

Formal statistical tests were conducted of the data presented in Table S5. Multilevel regression was used to properly account for the clustering at the level of the state and at the level of the twin pair. Separate multilevel regressions were performed predicting the three gambling outcomes from local area disadvantage, the density of local gambling venues, and their cross-level interaction. The interaction term represented a test of whether the association between local area disadvantage and the three gambling outcomes differed as a function of the density of gambling venues in the state or territory. The interaction terms were significant for the frequency of any gambling (t=4.24, df=4415.30, $p < .0001$), electronic machine gambling (t=3.23, df=4447.68, p=.001), and disordered gambling (t=3.04, df=3881.62, p=.002).

Additional References

Dal Grande, E., Taylor, A., Jury, H., & Greenland, N. (2004). *The Health Status of South Australians by Socio-Economic Status (SEIFA).* South Australian Department of Health. South Australia, Australia.