Genetic Influences on Activity Level: Do Situations Matter?

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Abstract

The present study used a multi-method, multi-situational approach to disentangle situational variance from method variance and explore cross-situational and context-specific genetic effects for Activity level (AL) at age 2. There was significant genetic variance specific to the methods used to assess AL, but there were no significant situation-specific genetic effects influencing individual differences in AL.

Introduction

- Research exploring cross-situational and context specific genetic influences on individual differences in activity level (AL) in early childhood has suggested substantial context-specific genetic variance in addition to cross-situational genetic variance (Philips & Matheny, 1997; Schmitz et al., 1996). In other words, although there are genetic effects that operate across situations, there are also genetic effects that are situationally-specific.
- However, these studies confound situational differences with method differences. For example, in the Schmitz et al. (1996) study, the informants differed across situation (i.e., the test and school situations). Similarly, in the Philips and Matheny (1997) study, both informants *and* measures differed across situations.
- This confound limits conclusions regarding cross-situational consistency and change because it is difficult to say whether the context-specific genetic variance refers to true situational change or method differences.
- The use of a multi-method, multi-situation approach in the present study permits a disentangling of method and situational variances and allows a strong test of situationally-specific genetic influences on AL.

Research Questions

- Do different measures of AL tap the same genetic influences?
- To what extent are there method specific and situational specific genetic influences on AL?

Methods

Sample

- 126 MZ and 143 DZ twin pairs assessed within 2 weeks of their 2nd birthday.

Procedure

- The procedure involved 2 visits, 48-hours apart, to the laboratory.

- At the initial visit:
    1. Actigraphs were attached.
    2. One twin was assessed in a standardized test situation, while the other twin was assessed within a laboratory play situation (see below).
    3. Parents were given questionnaires regarding the child temperament and related behaviors.
- At the second visit:
    1. Test/play situations were reversed for each twin.
    2. Actigraphs were removed and questionnaires collected.

Measures

- ***Mechanical Measure of AL.*** Minimitter Actical actigraphs were attached to all four limbs of each child. Actigraphs collect data in real time allowing us to examine AL during specific time segments (e.g., lab versus home; test versus play situations).
- ***Observational Measure of AL.*** Following the test and lab play situations, observers rated the AL of each child using the *Infant Behavior Record* (*IBR*, Bayley, 1969). The IBR Activity factor assesses general level of body motion and degree of energy exhibited during the situation.
- ***Parent Rating Measure of AL.*** Parents rated the AL of each child on the *Toddler Behavior Assessment Questionnaire* (*TBAQ*; Goldsmith, 1996) and the *EAS Temperament Survey* (*EAS;* Buss & Plomin, 1984).

Situations

- ***Home.*** The *Home* situation was broadly defined as all non-lab situations.
- ***Lab Test.*** The *Mental Scale of Bayley Scales of Infant Development–Second Edition (BSID - II;* Bayley, 1993) provided a structured test situation for assessing AL.
- ***Lab Play.*** The AL episodes, *arc of toys*; *fidgeting video; workbench*; and *corral of balls,* from the *Laboratory Temperament Assessment Battery - Preschool Version (Lab-TAB;* Goldsmith, Reilly, Lemery, Longley & Prescott, 1995) provided standard play situations for assessing AL.

Analyses

- An extended independent pathway model allowing for general genetic effects that operate across all measures, method-specific genetic effects, situation-specific genetic effects and measure-specific effects was fit to the data (Figure 7). Submodels were then fit to the data to test the significance of method and situation specific genetic effects.
- Prior analyses indicated that shared environmental influences were significant for only the actical home and TBAQ measures. Therefore, the model allowed a common shared environmental variance factor and specific shared environmental variances for these two variables.
- Nonshared environmental effects were parameterized using a Cholesky decomposition.

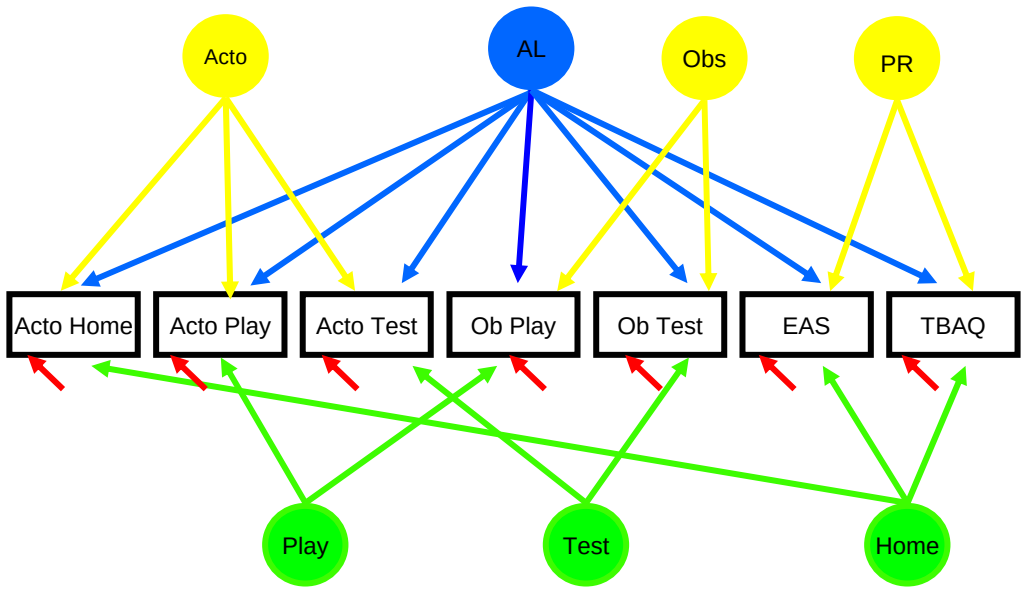

Figure 7. ***Methods and Situations Model.*** The blue AL factor represents genetic influences that are common across all 7 measures. The yellow Acto, Obs, and PR factors represent the actical, observer, and parent report, respectively, method-specific genetic effects. The green Play, Test, and Home factors represent situation-specific genetic effects. The red residual arrows are measure-specific genetic effects.

Results and Discussion

Agreement Across Measures and Situations (Table 1)

- Correlations between *different* measures of AL in the *same* situation (blue cells in Table 1) indicate that there was substantial convergent validity between observer ratings and actigraph AL in the test and play situations. Parent ratings of AL showed more moderate agreement with Home actigraph AL.
- Correlations between the *same* measures across *different* situations (green cells in Table 1) indicate cross-situational consistency of AL. Both observer ratings and the actigraph indicated substantial consistency in AL across the test and play situations. Moreover, when assessed via actigraph, AL in the lab was moderately associated with AL at home.

Table 1. Correlations between AL measures

	Parent		Observer		Actical	
	EAS	TBAQ	Test	Play	Test	Play
Parent						
TBAQ	.42*	--				
Observer						
Test	.15*	.13*	--			
Play	.19*	.14*	.63*	--		
Actical						
Test	.12	.15*	.61*	.44*	--	
Play	.10	.13*	.41*	.63*	.52*	--
Home	.17*	.25*	.13*	.16*	.35*	.33*

* $p < .05$. *Note.* Significance levels are based on number of twin pairs.

Model-fitting Results (Table 2)

- The best-fitting model (3 e below) included only the general factor and the method-specific factors. Both situation-specific and measure-specific factors could be eliminated without significantly worsening the fit of the model.

Table 2. Model Fitting Results

Model	χ^2	*df*	*p*	AIC	vs[a]	$\Delta\chi^2$	*df*	*p*
1. Saturated (2LL 16779.914, df=3506)								
2. Cholesky	178.20	147	.04	-115.80	1			
3. Methods & Situations Full	201.69	171	.06	-140.31	2	23.48	24	.55
a) drop General A	265.76	178	.00	-90.24	3	64.08	7	.00
b) drop Methods A	236.07	178	.00	-119.93	3	34.39	7	.00
c) drop Situations A	206.30	178	.07	-149.70	3	4.61	7	.71
d) drop Specifics A	201.82	178	.11	-154.18	3	.13	7	.99
e) drop Situations & Specifics	***214.58***	***185***	***.07***	***-155.42***	***3***	***12.89***	***14***	***.54***

Note. [a]Comparison model. $\Delta\chi^2$ refers to relative fit of the model compared to the comparison model. Best-fitting model in bold.

- AL was significantly heritable for all measures, and to some extent, the same genetic influences operate across methods and situations (as indicated by the significant general factor).
- There was significant genetic variance specific to the methods used to assess AL. In contrast, there were no significant situation-specific genetic effects influencing individual differences in AL. This suggests that genetic factors contribute to cross-situational continuity, not situational change.
- Prior research which report contextual or situation-specific genetic effects on AL likely reflect method variance, not situational variance.
- Figure 8 decomposes the heritiabilities for each measure into general effects that are common across all 7 measures (A General) and method-specific effects (A Method). The pattern of results for situations within a method (i.e., actical or observer) suggests that although there is no genetic variance unique to a situation, situations do matter in that they moderate the impact of the method. For example, method-specific genetic effects contribute more to the actical in the home than either of the two lab situations. There are also situational differences in the magnitude of heritability.

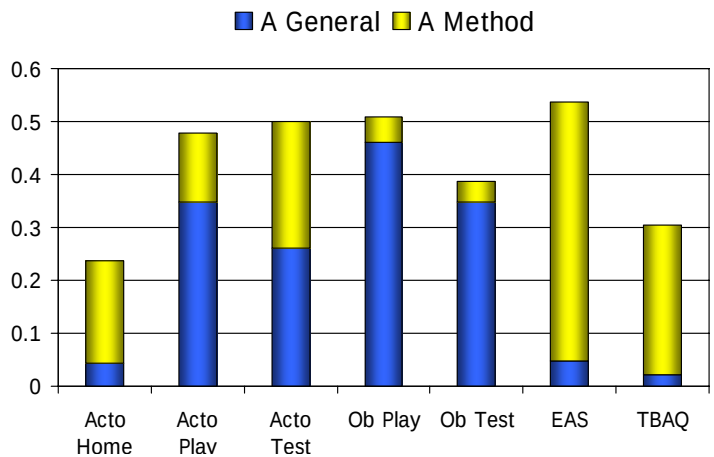

Figure 8. ***Heritiabilities of each AL measure decomposed into general genetic effects (blue) and method-specific effects (yellow).***

- Approximately 90% of the genetic variance for parent rating measures is method specific. Thus, to a considerable extent, the genetic effects on parent-rating measures of AL are independent from those assessed via actical or observer rating.
- These findings have important implications for molecular genetic studies of AL and related behaviors: situations may not matter so much when searching for specific genes associated with AL, but the measure used may matter a great deal. Failures to replicate molecular genetic findings may be due to a failure to use the same methodology.

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