Genetics and co-occurrence of Stuttering, Cluttering, and Childhood Speech-language Disorders

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Background

- Childhood Speech-language-Disorders
- Stuttering
- Cluttering
- Coexistence of Childhood speech-language disorders, Stuttering and Cluttering

Comorbidity of Childhood Speech-language Disorders, Stuttering and/or Cluttering

- Coexisting of speech-language disorder and stuttering
- Coexisting of speech-language disorder and cluttering
- Coexisting of stuttering and cluttering

  have been reported and we like to estimate this in biometric models.
- We would also like to estimate biometric models which include all three traits, childhood speech-language disorders, stuttering and cluttering.

Combinations of childhood speech-language disorders, Stuttering and Cluttering

- Treitel (1892)
- Gutzmann (1893)
- Liebman (1900)
- Scripture (1912)
- Weiss (1935)
- Pichon & Borel-Maisonny (1937)
- De Hirsch & Langford (1950)
- Gedda, Bracconi & Bruno (1960)
- Luchsinger (1963)
- Van Riper (1971)

Aims

1. *to examine the role of genetic and environmental factors in the development of childhood speech-language disorders, stuttering and cluttering*
2. *to investigate the coexisting of stuttering, cluttering and childhood speech-language disorders*
3. *to establish to what extent the coexisting can be explained by overlapping genetic factors or environmental influences shared by the three disorders.*

The 2002 Twin Survey

- 46,418 twins born 1931-1982 (population based).
- 34,944 returned a filled questionnaire (75 %)
- Questionnaire survey with 10 research groups involved
- Research questions on
  - arthritis, thyroid diseases, neck and back pain, scoliose, asthma and allergy, speech- and hearing problems, obesity, fertility, emotional repression, and obsessive compulsory disorder (OCD)
  - functioning, activity, disability, diseases, education, occupation, socio-economic factors, family relations and children, smoking, alcohol, general health, SF12

Method

The questions used from the omnibus survey were about *childhood speech-language disorders, stuttering and cluttering:*

- ***Did you have speech-language disorder in your childhood?***
- ***Do you stutter or have you stuttered?***
- ***Do you speak too fast or did you do so, stumbling over the words and omitting syllables (cluttering)?***

Table 1	MZ, SSDZ or OSDZ	Number of reported negative or positive answers to this question	Number of positive answers to this question	Prevalence for ever having had
Males from same gender pairs				
Speech	MZ	3830	472	0.123
Speech	SSDZ	5854	565	0.097
Stuttering	MZ	3936	325	0.083
Stuttering	SSDZ	6005	498	0.083
Cluttering	MZ	3934	595	0.151
Cluttering	SSDZ	6010	756	0.126
Females from same gender pairs				
Speech	MZ	4849	325	0.067
Speech	SSDZ	6557	413	0.063
Stuttering	MZ	4947	187	0.038
Stuttering	SSDZ	6674	245	0.037
Cluttering	MZ	4943	662	0.134
Cluttering	SSDZ	6682	754	0.113
Males (M) and Females (F) from opposite gender DZ pairs				
Speech	OSDZ(M)	5060	507	0.100
Speech	OSDZ(F)	6398	277	0.043
Stuttering	OSDZ(M)	5197	458	0.088
Stuttering	OSDZ(F)	6558	185	0.028
Cluttering	OSDZ(M)	5187	664	0.128
Cluttering	OSDZ(F)	6552	639	0.098

Probandwise concordance rate

is the probability that the trait occurs in a twin given it has already occurred in the co-twin

Difference in concordance rate between MZ and DZ pairs suggests genetic effects.

Table 2	MZ or SSDZ	Number of pairs	Number of concordant pairs	Number of discordant pairs	Prevalence	Probandwise Concordance	Tetrachoric correlation	Estimated Heritability	Best Model
Males from same gender pairs									
Speech	MZ	649	42	79	0.13	0.52	0.79	0.79	AE
Speech	SSDZ	825	22	125	0.10	0.26	0.40		
Stuttering	MZ	689	36	48	0.087	0.60	0.85	0.84	ADE
Stuttering	SSDZ	880	6	123	0.077	0.09	0.071		
Cluttering	MZ	684	48	118	0.16	0.45	0.62	0.62	AE
Cluttering	SSDZ	875	20	160	0.11	0.20	0.31		
Females from same gender pairs									
Speech	MZ	945	36	49	0.064	0.60	0.87	0.86	AE
Speech	SSDZ	1170	15	114	0.062	0.21	0.35		
Stuttering	MZ	995	21	36	0.039	0.54	0.84	0.81	AE
Stuttering	SSDZ	1207	4	92	0.041	0.08	0.15		
Cluttering	MZ	992	65	135	0.13	0.49	0.70	0.69	AE
Cluttering	MZ	1209	33	216	0.12	0.23	0.32		

Tetrachoric correlation in the ”liability-threshold” model

Tetrachoric correlation is the correlation in twin liability to the trait and independent of trait prevalence

A significant higher correlation in MZ compared to DZ pairs point to genetic influences on liability to the trait

Table 2	MZ or SSDZ	Number of pairs	Number of concordant pairs	Number of discordant pairs	Prevalence	Probandwise Concordance	Tetrachoric correlation	Estimated Heritability	Best Model
Males from same gender pairs									
Speech	MZ	649	42	79	0.13	0.52	0.79	0.79	AE
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Stuttering	SSDZ	880	6	123	0.077	0.09	0.071		
Cluttering	MZ	684	48	118	0.16	0.45	0.62	0.62	AE
Cluttering	SSDZ	875	20	160	0.11	0.20	0.31		
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Statistical Methods and Genetic Modeling with M_x

- ***Univariate analysis of the three dichotomous traits separately***
- ***Bivariate Cholesky-decomposition analysis***
- ***Multivariate scenario***

A = Additive genetic effects

C = Common environmental effects (experiences that make children growing up in the same family similar)

D = Non-additive genetic effects

E = Non-shared (individual-specific) environmental effects (influences that make children growing up in the same family different: e.g. adequacy of blood supply, position in the womb, birth complications, different home, infections, traumas).

Univariate gender-limitation modeling

- Additive genetic effects (A), and
- Either common environmental effects (C), or non-additive genetic effects (D), and
- Non-shared individually environmental effects (E).

- **The combinations ACE, ADE, AE, CE, and E are possible.**

The best fitting univariate biometric models for men and women

Table 3	A	D	E	Best models
Speech-language disorders	0,79♂ - 0,86♀	AE models	0,21♂ – 0.14♀	AE ♂♀
Stuttering	0,82♂ - 0,81♀	0,02♂ – AE ♀	0,16♂ – 0.19♀	ADE♂ - AE♀
Cluttering	0,62♂- 0,69♀	AE models	0,38♂ – 0.31♀	AE ♂♀

A: Additive genetic effects

D: Genetic dominance

E: Non-shared environmental effects

♂: Men

♀: Women

Number of twin pairs and bivariate Cholesky decomposition analysis

Table 4	MZ, SSDZ and OSDZ twin pairs			Estimated heritability	Best model
	Number of pairs	Number of concordant pairs	Number of discordant pairs		
Speech-language disorders	5.296	127	547	0,78	ADE
Stuttering	5.565	77	480	0,85	ADE
Cluttering	5.547	202	932	0,62	AE

MZ: Monozygotic twins

SSDZ: Same Sex Dizygotic twins

OSDZ: Opposite Sex Dizygotic twins

Multivariate scenario

- A Cholesky decomposition was fitted to the three dichotomous traits and covariances between the traits were modelling to a trivariate scenario.
- The best fitting trivariate model provides estimates of genetic and environmental influences for the traits and of genetic correlations between them.

Estimated heritabilities in AE models in a trivariate analysis and correlation of the relative effects of additive genetic factors

Table 5	Variance components		Genetic correlations		
	A	E	Speech disorders	Stuttering	Cluttreing
Speech disorders	0,71♂ - 0,87♀	0,29♂ – 0.13♀	1	0,71 ♂	0,73 ♂
Stuttering	0,78♂ - 0,80♀	0,22♂ – 0,20♀	0,79 ♀	1	0,53 ♂
Cluttering	0,53♂- 0,66♀	0,47♂ – 0,34♀	0,56 ♀	0,57 ♀	1

A: Additive genetic effects

E: Non-shared environmental effects

♂: Men

♀: Women

Estimated heritabilities in AE models in a trivariate analysis

and correlation of the relative effects of non-shared environmental effects

Table 6	Variance components in AE model		Environmental correlations		
	A	E	Speech disorders	Stuttering	Cluttering
Speech disorders	0,71♂ - 0,87♀	0,29♂ – 0.13♀	1	0,92 ♂	0,29 ♂
Stuttering	0,78♂ - 0,80♀	0,22♂ – 0,20♀	0,86 ♀	1	0,63 ♂
Cluttering	0,53♂- 0,66♀	0,47♂ – 0,34♀	0,79 ♀	0,35 ♀	1

A: Additive genetic effects

E: Non-shared environmental effects

♂: Men

♀: Women

This study demonstrates substantial mutual genetic influence for the traits of speech-language disorders in childhood, stuttering and cluttering.
If you want to join us for further processing of our data or for further projects using our data please let us know.

References

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