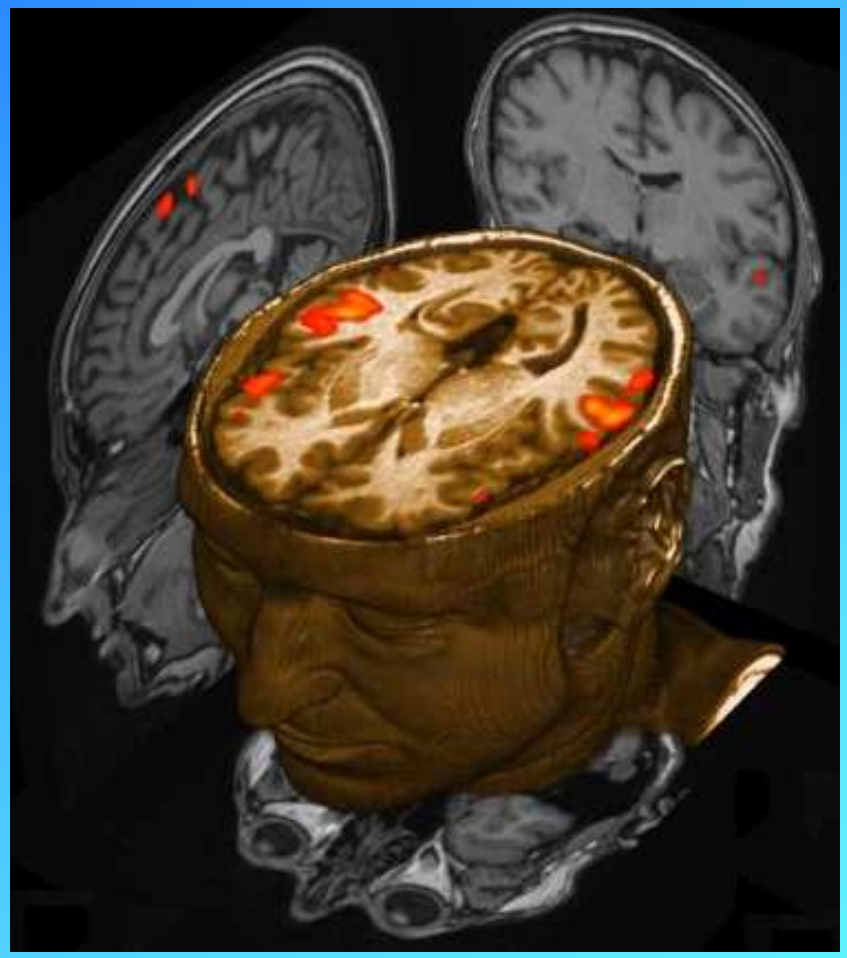
Neuroimaging correlates of personality traits



Simona Gardini
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In collaboration with

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Ospedale San Camillo (IRCCS)
Venezia Lido, Italy

Personality and brain function

- There is a relationship between personality traits and brain?
- What could this association mean in addiction?

Personality framework

A PSYCHOBIOLOGICAL MODEL OF PERSONALITY

CLONINGER (1986, 1987, 1993)

- **Dimensions of temperament are associated with different neurobiological patterns.**

Personality assessment

Why the Three-dimentional Personality Questionnaire?

- Because the TPQ was designed based on neurobiology of brain systems, rather than by factor analysis that ignores information about the evolution, structure and function of the brain.

Personality assessment

Three-dimensional Personality Questionnaire (TPQ)

Each dimension of temperament includes four subscales.

Novelty seeking

Exploratory
Impulsive
Extravagant
Disorderly

Harm Avoidance

Pessimistic
Fearful
Shy
Fatigable

Reward Dependence

Sentimentality
Attachment
Persistence
Dependence

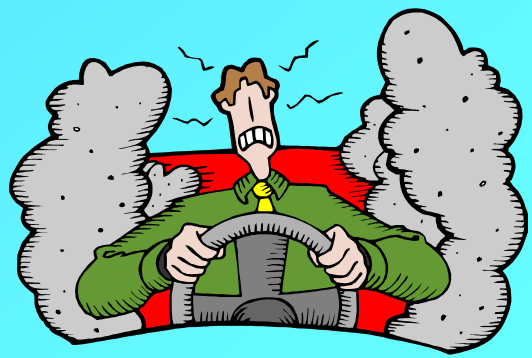
Persistence (PER) is a ***fourth independent personality dimension.***

Novelty Seeking (NS)

- Genetic tendency to action behaviours and exploratory activity in response to novelty

- Impulsive decision making, extravagant approach to reward and quick loss of temper.

Example of an item for NS (answered yes):
"Usually I think I am able to do things that most people judge as dangerous, such as driving a car at high speed on a wet or icy road, without any difficulties "



Harm Avoidance (HA)

- Innate tendency to inhibit behaviours, caution, apprehensiveness and pessimism

- Pessimistic anticipation of future problems, passive avoidant behaviour, fear of uncertainty, shyness of strangers, rapid fatigability and anxiety.

Example of an item for HA (answered yes): "Often I have to stop doing what I am doing because I start worrying that something might go wrong".

Reward Dependence (RD)

- **Innate tendency towards the maintenance of ongoing behaviours previously associated with reward**

- **Sentimentality, social attachment and dependence on the approval of others.**

Example of an item for RD (answered yes): "I like to discuss openly with friends about my experiences and my feelings instead of keep them for me".

Persistence (PER)

- Ability to generate and maintain arousal and motivation internally, in the absence of immediate external reward.
- Industrious, diligent, hardworking, ambitious, overachieving and perfectionist.

Example of an item for PER (answered no): "I am satisfied with my accomplishment, and have little desire to do better."

Personality traits and neurotransmitters

- **Personality traits are associated with different neurotransmitter systems** (Cloninger, 1996; Siegel, 1996; Gerra et al., 2000)

Novelty Seeking → **Dopaminergic Activity**

Harm Avoidance → **Serotoninergic Activity**

Reward Dependence → **Noradrenergic Activity**

Personality traits and the Brain

- Individual differences in personality traits could be associated with the structural and functional variability of specific areas of the brain

- From the neural basis of personality to the functional architecture of the brain

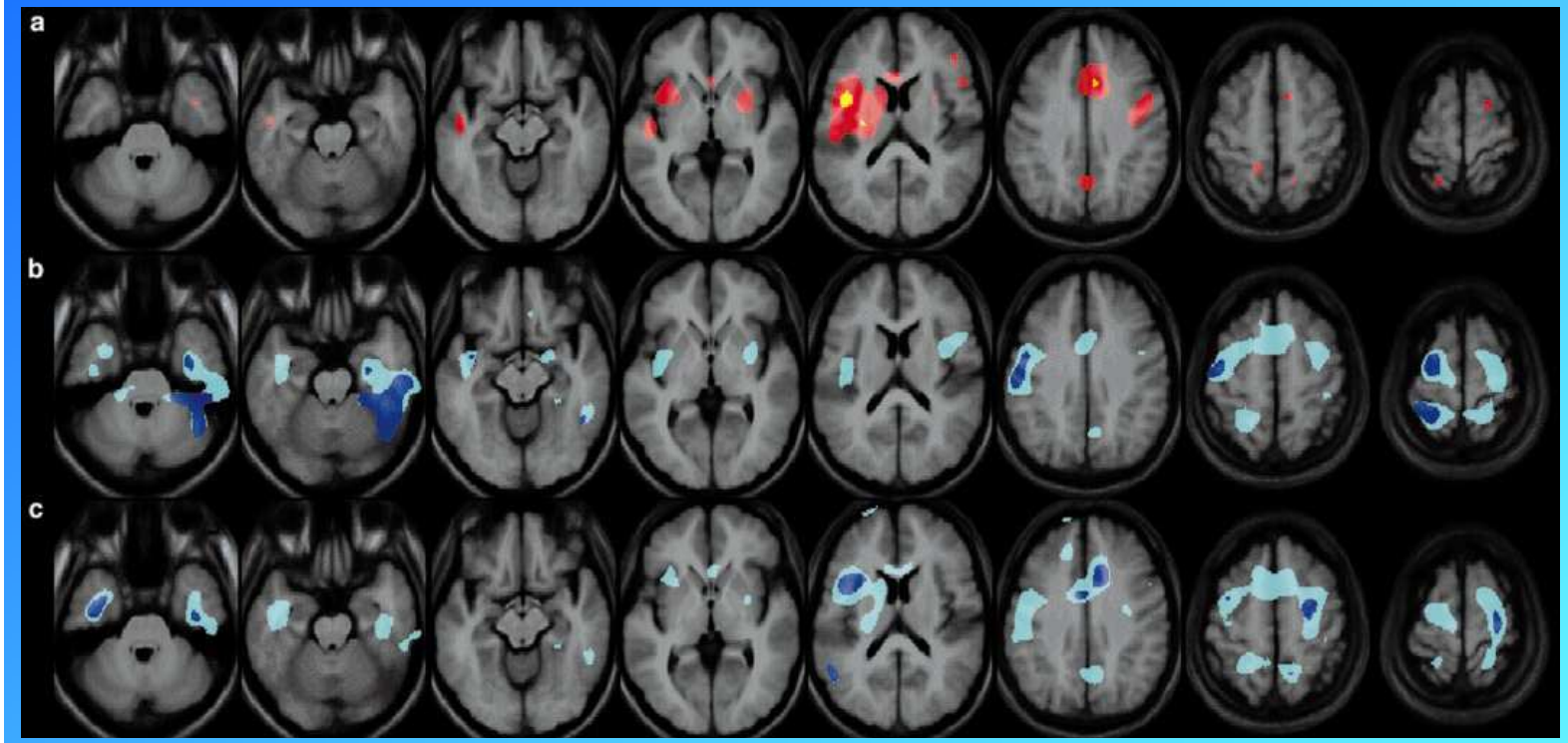
Personality traits and the Brain

- Limited neuroimaging evidence exist showing that personality dimensions correlate with specific characteristics of the brain.

NeuroImage 11, 541–546 (2000)

Correlation between Human Personality and Neural Activity in Cerebral Cortex

Motoaki Sugiura,* Ryuta Kawashima,*·† Manabu Nakagawa,* Ken Okada,* Tachio Sato,* Ryoi Goto,* Kazunori Sato,* Shuichi Ono,* Thorsten Schormann,‡ Karl Zilles,‡·§ and Hiroshi Fukuda*·†



SPECT data
rCBF correlation with NS, HA, RD

+ red/ yellow
- cyan/blue

NS (a)	HA (b)	RD (c)
+ cingulate, insula	- fronto, medio temporal	- cingulate, insula, frontal/ medio temporal

NeuroImage 11, 541–546 (2000)

Correlation between Human Personality and Neural Activity in Cerebral Cortex

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- **NS is associated with the paralimbic cortex and HA and RD are associated with neocortical regions and paralimbic cortex.**

- **These results are consistent with the influence of monoaminergic activity in each personality dimension.**

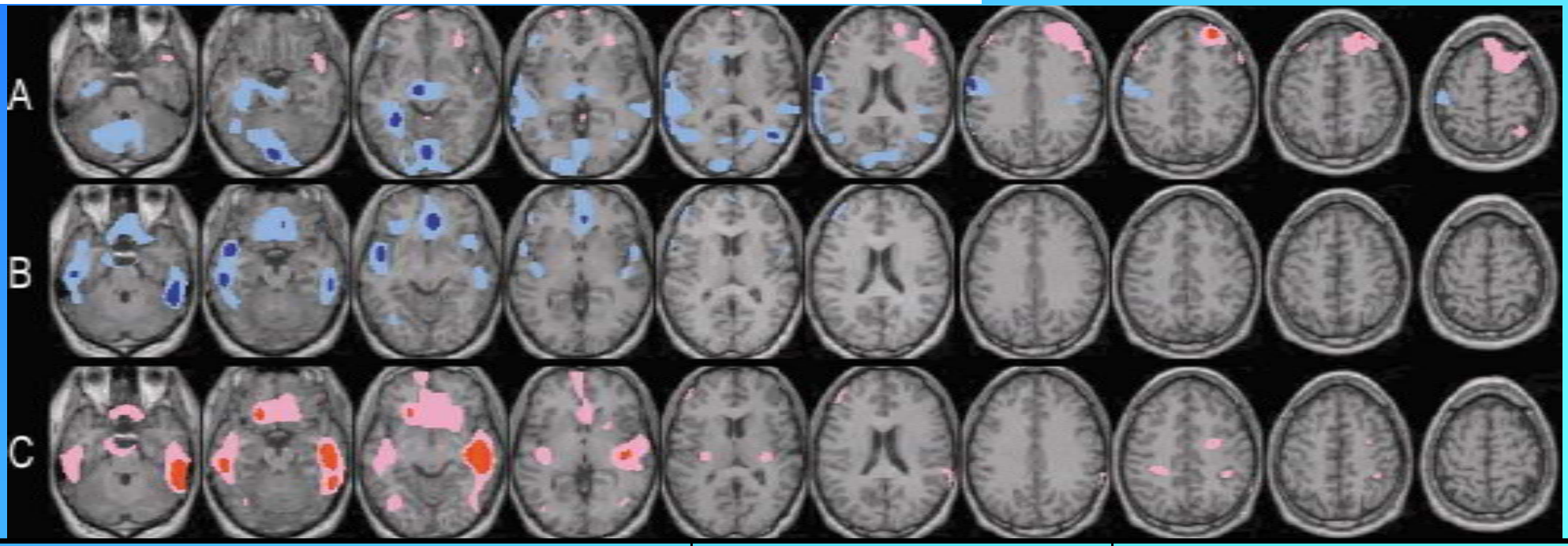
Biological Psychology 60 (2002) 109–120

Relationship between personality trait and regional cerebral glucose metabolism assessed with positron emission tomography

Tak Youn [a,b], In Kyoon Lyoo [a], Jae-Jin Kim [c], Hae-Jeong Park [b], Kyoo-Seob Ha [a], Dong Soo Lee [b,d], Kelley Yost Abrams [b], Myung Chul Lee [b,d], Jun Soo Kwon [a,b,d,*]

PET study
Correlations among glucose metabolism and NS (A), HA (B), RD (C).

+ red/pink
- blue/cyan



NS (A)	HA (B)	RD (C)
- substantia nigra, medio-temporal; + right middle frontal lobe	- temporo-frontal	+ orbito-frontal, temporal

Biological Psychology 60 (2002) 109–120

Relationship between personality trait and regional cerebral glucose metabolism assessed with positron emission tomography

Tak Youn [a,b], In Kyoon Lyoo [a], Jae-Jin Kim [c], Hae-Jeong Park [b], Kyoo-Seob Ha [a], Dong Soo Lee [b,d], Kelley Yost Abrams [b], Myung Chul Lee [b,d], Jun Soo Kwon [a,b,d,*]

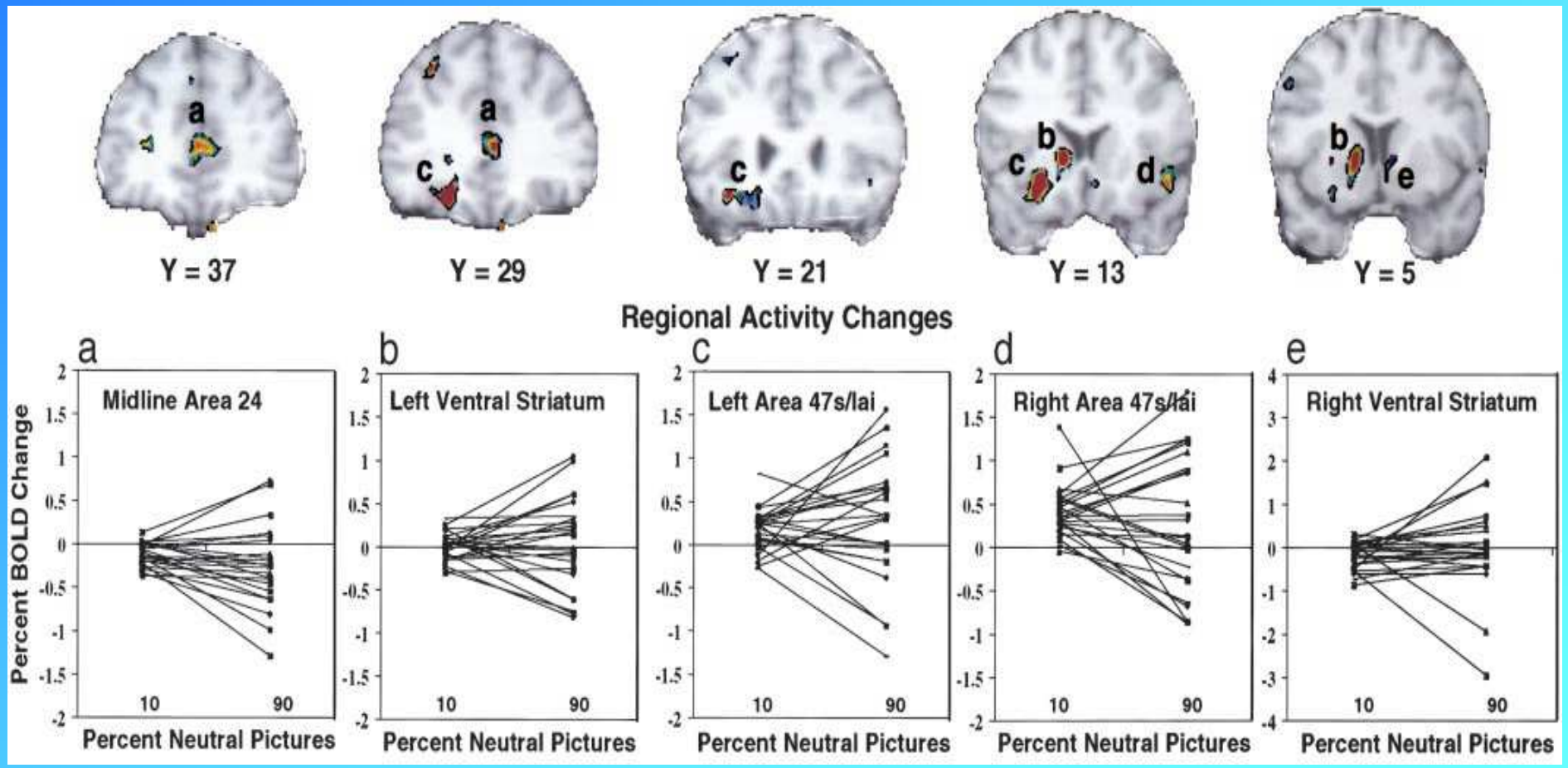
- The association between NS and the substantia nigra, rich in dopaminergic cells, supports the relationship between dopamine and NS
- HA and RD correlated with temporal and orbitofrontal regions, which are involved in emotional controls and personality

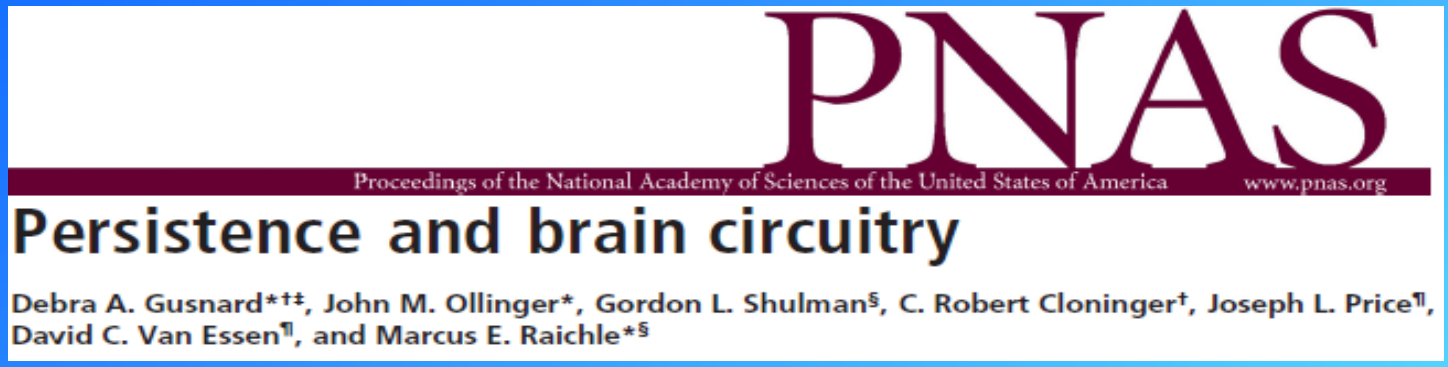
PNAS
Proceedings of the National Academy of Sciences of the United States of America www.pnas.org

Persistence and brain circuitry

Debra A. Gusnard*†‡, John M. Ollinger*, Gordon L. Shulman§, C. Robert Cloninger†, Joseph L. Price¶, David C. Van Essen¶, and Marcus E. Raichle*§

- **Functional MRI correlations of Persistence**





- These orbitomedial prefrontal areas and ventral striatum are implicated in behavioural persistence.

- Activations were most prominent for neutral pictures than emotional ones:

Individuals high in Persistence may represent less arousing situations as intrinsically motivated, than individuals low in Persistence.

Cerebral Cortex January 2008;18:46-52
doi:10.1093/cercor/bhm030
Advance Access publication April 5, 2007

Gender-Common and -Specific Neuroanatomical Basis of Human Anxiety-Related Personality Traits

Hidenori Yamasue[1], Osamu Abe[2], Motomu Suga[1], Haruyasu Yamada[2], Hideyuki Inoue[1], Mamoru Tochigi[1], Mark Rogers[1], Shigeki Aoki[2], Nobumasa Kato[1] and Kiyoto Kasai[1]

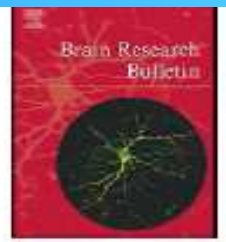
- MRI study
- HA (anxiety-related trait) correlated with smaller grey matter in the right hippocampus.
- Female-specific correlation was found in the left anterior prefrontal cortex.

- *This study, however, did not extend its investigation to other personality dimensions (NS, RD, PER).*

Contents lists available at ScienceDirect

Brain Research Bulletin

journal homepage: www.elsevier.com/locate/brainresbull



Research report

Individual differences in personality traits reflect structural variance in specific brain regions

Simona Gardini[a,b], C. Robert Cloninger[c], Annalena Venneri[b,d,*]

- **We investigated if novelty seeking, harm avoidance, reward dependence and persistence was associated with structural changes in grey matter density in specific regions of the brain.**

PARTICIPANTS

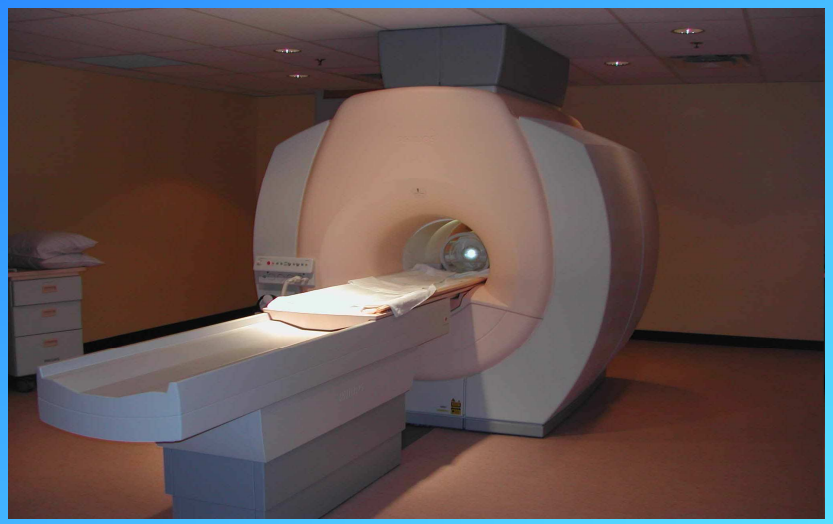
85 young adults (58 males, 27 females, mean age 32.69, SD 6.48, mean education 14.15, SD 4.92) took part in this study.

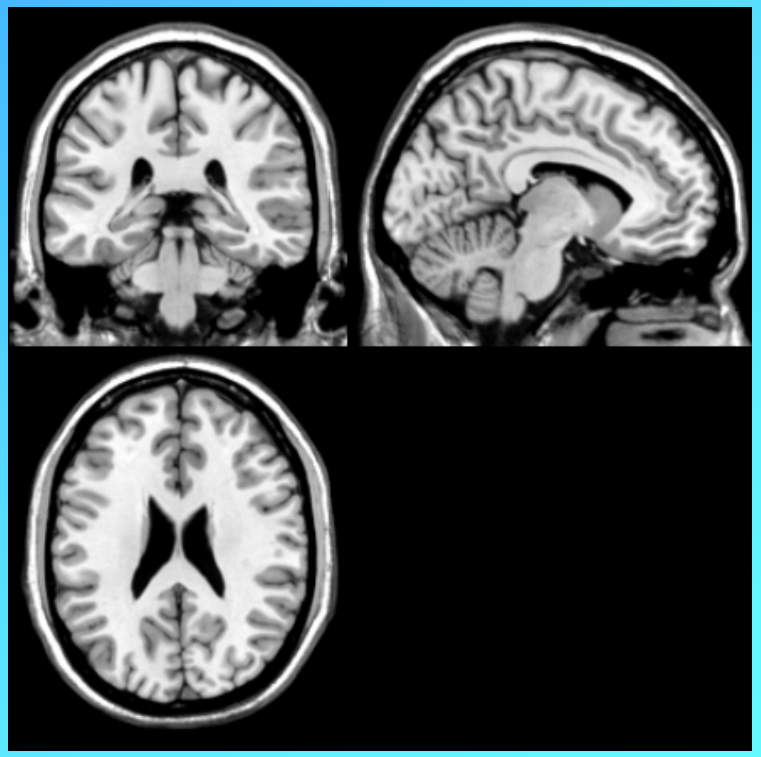
METHODS

All participants filled in the TPQ and then underwent to brain scanning with Magnetic Resonance Imaging (MRI).

Brain scanning

- For each participant a three-dimensional MRI image of the brain was acquired on the same 3T MRI scanner.



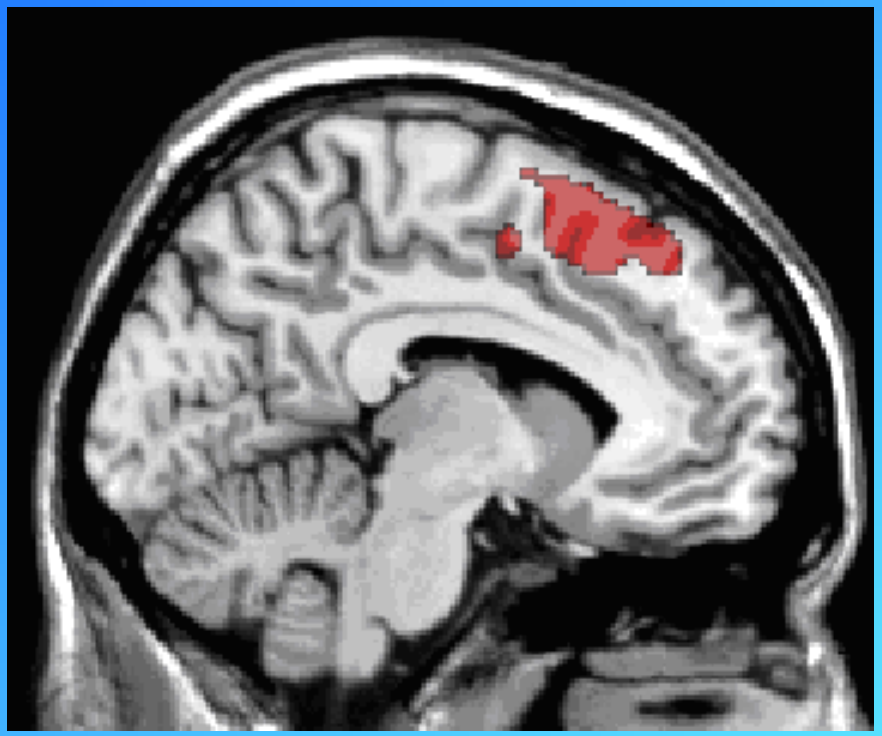


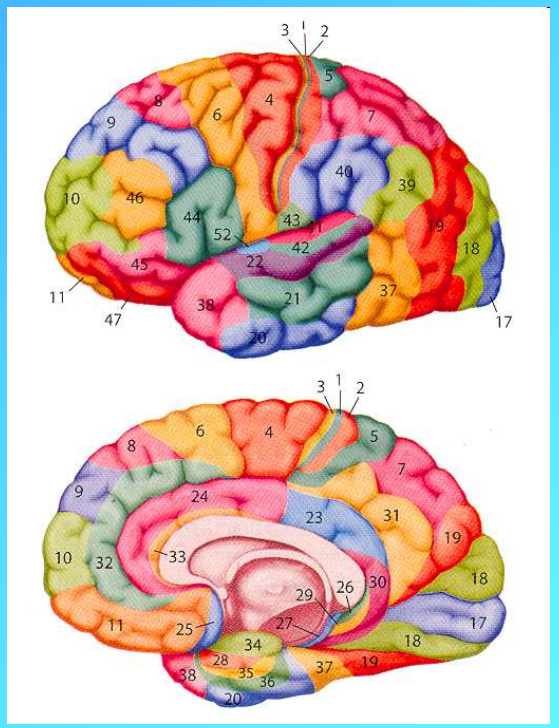
DATA ANALYSIS

- Positive and negative correlations between grey matter concentration and the personality traits obtained on the TPQ were carried out using Statistical Parametric Mapping (SPM5).

Results Novelty Seeking

- Positive correlation between NS and grey matter density in right superior and middle frontal gyri and in the posterior cingulate gyrus.





Brain area	Left/right	Brodmann area (BA)	Cluster size	Talairach coordinates		
				x	*y*	*z*
Superior frontal gyrus	R	6	1292	10	8	53
Middle frontal gyrus	R	6		20	9	60
Superior frontal gyrus	R	8	1135	8	28	50
Posterior cingulate gyrus	R	23		2	−59	18

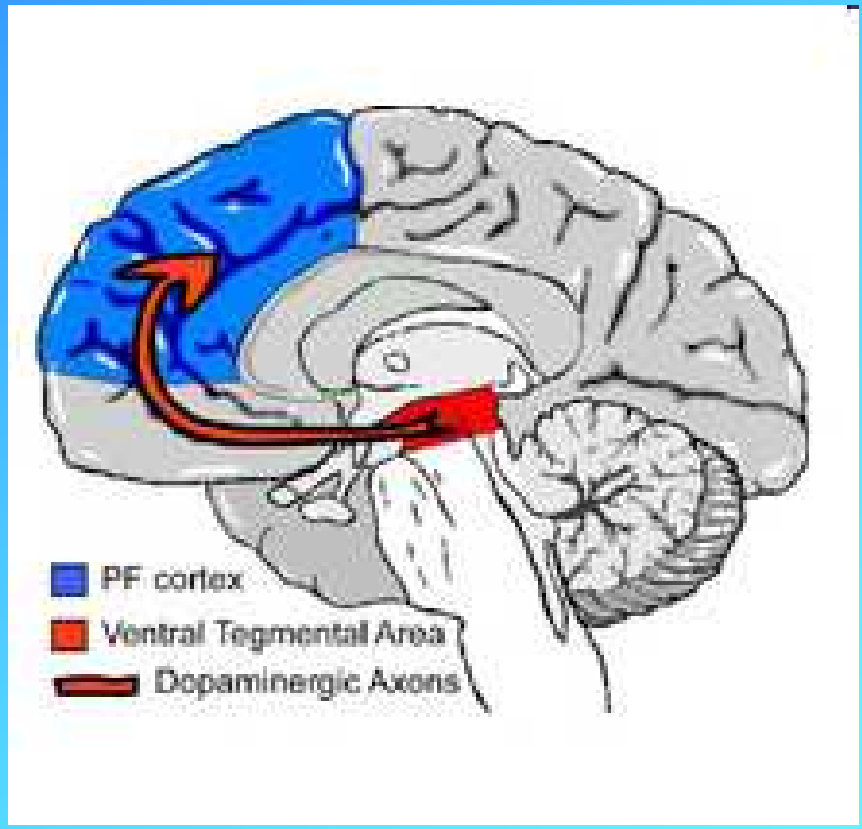
Results Novelty Seeking

- These frontal regions are involved in planning complex coordinated motor actions.

- People who score highly on NS is more prone for risky, exploratory and perceptually rich stimuli/behaviours.

Results Novelty Seeking

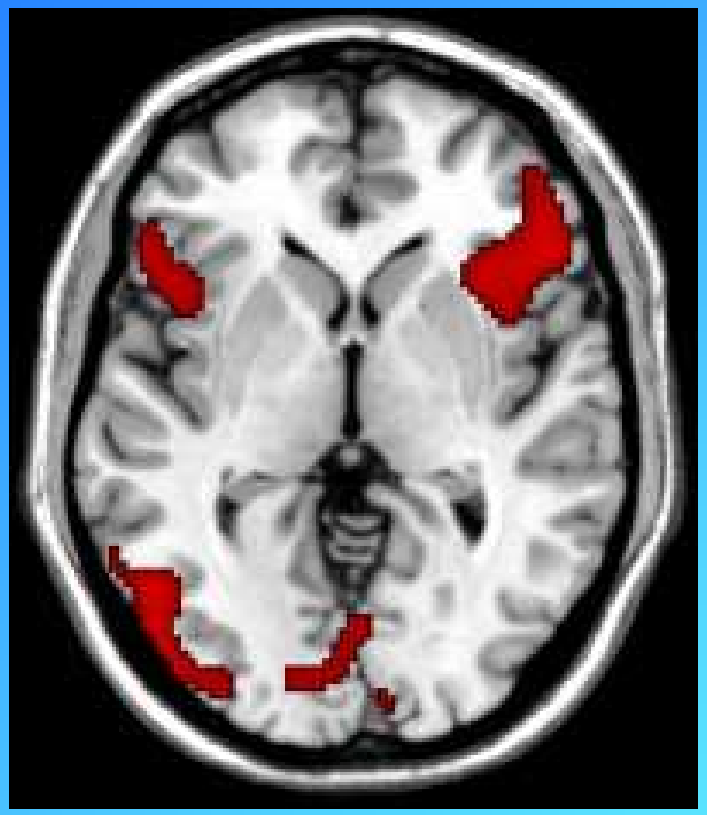
- The positive correlation with frontal areas, rich in dopamine projections, seems to confirm the relationship between NS and dopaminergic activity.



Dopaminergic pathway

Results Harm Avoidance

- A negative correlation between HA and grey matter volume was found bilaterally in the inferior frontal gyri and parietal lobule, left middle occipital gyrus and middle frontal gyrus.



Brain area	Left/right	Brodmann area (BA)	Cluster size	Talairach coordinates		
				x	*y*	*z*
Precuneus	L	31	3941	−22	−74	28
Middle occipital gyrus	L	19		−50	−77	6
	L	19		−34	−81	19
Inferior frontal gyrus	L	9	2645	−50	19	25
	L	46		−46	28	12
Middle frontal gyrus	L	8		−24	25	43
Inferior frontal gyrus	R	47	1528	51	27	−3
	R	47		40	21	−1
	R	46		42	36	11
Cuneus	R	19	776	28	−80	28
Inferior parietal lobule	R	7		42	−64	47
	R	40		34	−50	56

Results Harm Avoidance

- Less structural development of orbito-frontal areas, involved in emotion and anxiety control, might underline the development of a highly HA personality.

- Lower grey matter density in posterior–occipital regions might suggest a degree of behavioural inhibition and aversion for perceptually rich stimuli in people high in HA.

Results Reward Dependence

- RD was negatively correlated with grey matter volume in the right caudate and rectal frontal gyrus.

Brain area	Left/right	Brodmann area (BA)	Cluster size	Talairach coordinates		
				x	*y*	*z*
Caudate nucleus	R		10	12	5	15
Rectal gyrus	R	11		4	22	−21

Results Reward Dependence

- Fronto-striatal areas are specialised in the control of behaviour, emotional reward and motivation.

- Less grey matter in this circuit might expresses itself with a personality that is highly dependent on reward.

Results Persistence

- Persistence showed a significant positive correlation in the right paracentral lobule, parahippocampal gyrus and in the left precuneus.

Brain area	Left/right	Brodmann area (BA)	Cluster size	Talairach coordinates		
				x	*y*	*z*
Precuneus	L	7	23	−2	−74	44
Paracentral lobule	R	5	22	10	−40	57
Parahippocampal gyrus	R	36		40	−30	−24

Results Persistence

- The precuneus plays a role in self-processing and consciousness, persevering in actions and decision to act, aspects which characterize a persistent personality.

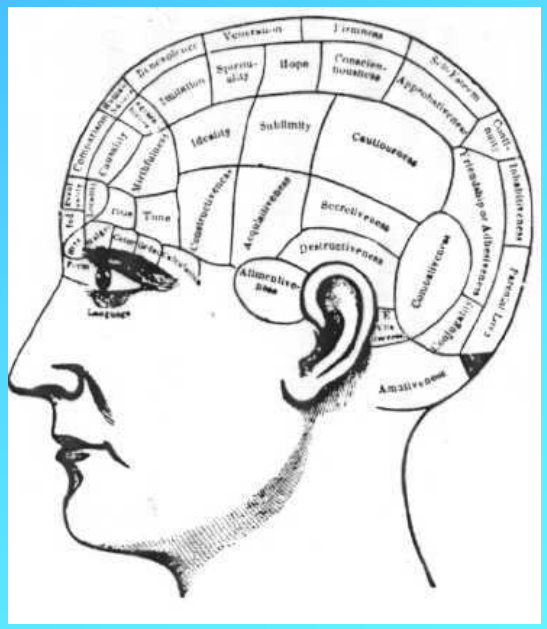
- Variance in parahippocampal structures might be related to self-representative memory.

Conclusion Personality & Brain

- There is a relationship between personality traits and specific brain regions?

YES

- Close correspondence between the development of some personality profiles and the structural variability of specific neural regions.



Nature versus Nurture

Morphological brain variability

predisposing factor to the development of individual differences in personality traits

byproduct of personality traits, resulting from repeated behaviours and environmental exposures.

- ***Genotypically-defined variability in brain morphology expresses phenotypically as individual differences in personality traits.***

- What could the relationship between personality traits and brain this association mean in addiction?

Conclusion Personality, the Brain and Addiction

▪ Personality disorders underlined by altered genetic and neurobiological substrates may constitute a vulnerability factor for the development of addiction.

Predictors of drug abuse:

- Temperament (novelty and sensation seeking)
- Personality traits (Aggressiveness, impulsivity)
- Anxiety mood
- Neglect and abuse
- Social deprivation
- Poor parenting
- Lack of school engagement
- Adverse stressful life events during childhood
- Low future projects and lack of vocational perspectives

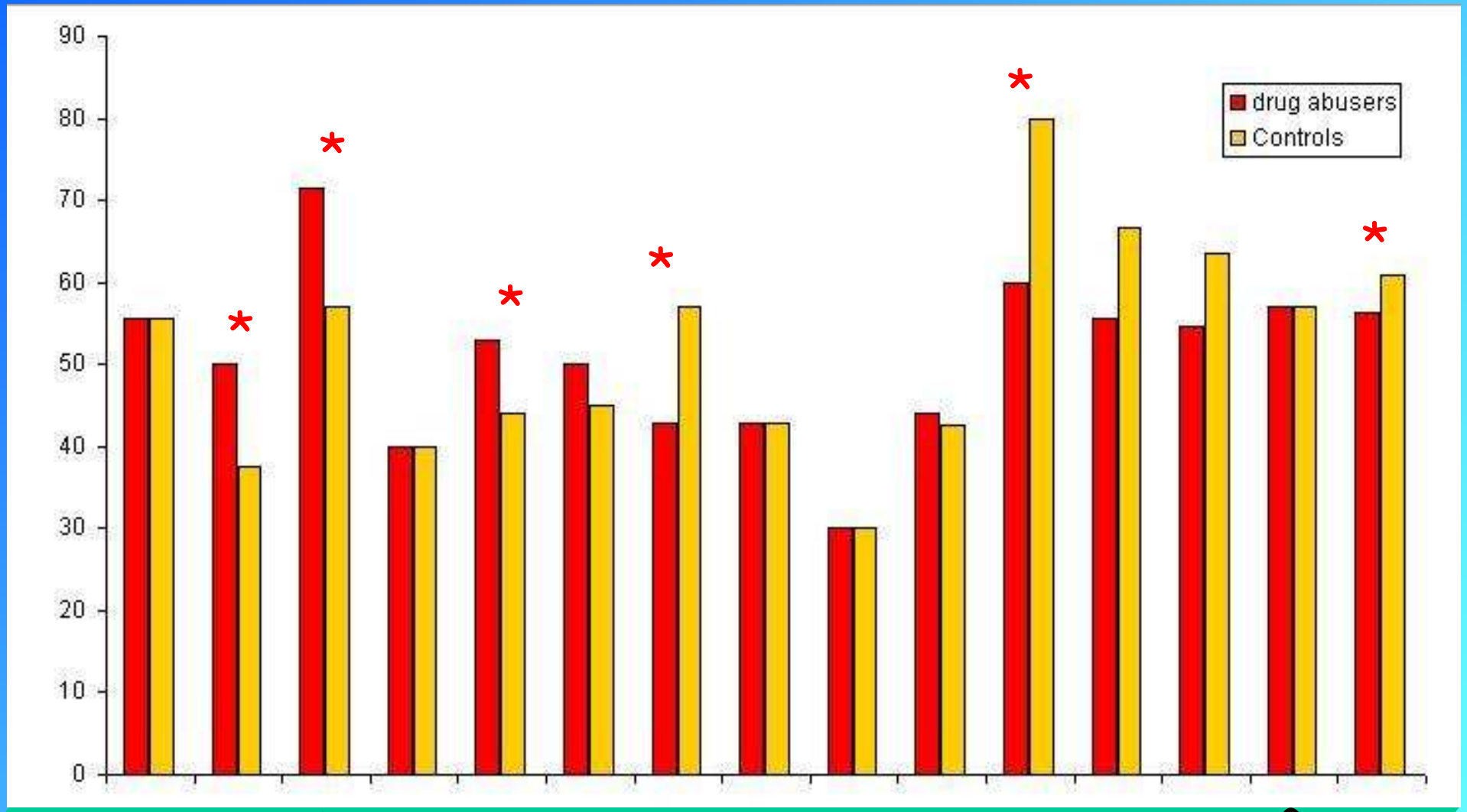
Conclusion Personality, the Brain and Addiction

- A group of drug abusers (N=47) was compared with a group of healthy controls (N=56) in the TPQ scores

	Mean Scores (Standard Deviation)		
	Controls	Drug Abusers	P value
Novelty Seeking Total	**45.16 (13.54)**	**55.69 (13.17)**	**< .000**
Exploratory	52.38 (18.43)	56.50 (17.00)	n.s.
Impulsiveness	**37.72 (25.39)**	**50.53 (25.66)**	**= .013**
Extravagance	**52.79 (18.65)**	**73.85 (19.60)**	**< .000**
Disorderly	39.28 (19.89)	46.38 (21.81)	n.s.
Harm Avoidance Total	43.96 (18.31)	46.30 (16.59)	n.s.
Pessimistic	45.35 (23.35)	50.21 (21.81)	n.s.
Fearful	**59.69 (22.31)**	**50.45 (24.17)**	**< .05**
Shy	49.49 (22.45)	53.79 (24.95)	n.s.
Fatigable	27.67 (24.19)	34.25 (24.38)	n.s.
Reward dependence Total	**62.61 (13.20)**	**56.25 (14.18)**	**= .021**
Sentimentality	**73.57 (21.94)**	**61.27 (26.17)**	**= .011**
Attachment	62.89 (22.45)	56.26 (22.86)	n.s.
Persistence	61.03 (20.19)	54.73 (21.98)	n.s.
Dependence	56.88 (21.53)	55.01 (22.87)	n.s.

Gardini and Venneri in preparation

Conclusion Personality, the Brain and Addiction



Gardini and Venneri In preparation

Conclusion Personality and Brain and Addiction

- Personality traits (such as Novelty Seeking) may represent a vulnerability factor for substance abuse.

Dughiero G, Schifano F, Forza G (2001) Personality dimensions and psychopathological profiles of Ecstasy users. Hum Psychopharmacol. 16:635-639.

Gerra G, Garofano L, Castaldini L, Rovetto F, Zaimovic A, Moi G, Bussandri M, Branchi B, Brambilla F, Friso G, Donnini C. (2005). Serotonin transporter promoter polymorphism genotype is associated with temperament, personality traits and illegal drugs use among adolescents. J Neural Transm., 112, 1397-410.

Conclusion Personality, the Brain and Addiction

- Neurobiological vulnerability of addiction (Koob and Volkow, 2010)

- Limbic subcortical structures (Blum et al., 2000)

- Frontal cortex (Goldstein and Volkow, 2002; Pau et al., 2002; Fein et al., 2002).

- Insular deficits (Naqvi and Bechara, 2010; Gardini and Venneri, under revision)

Conclusion Personality, the Brain and Addiction

- Genetic vulnerability of addiction

J Neural Transm (2005) 112: 1397–1410

Journal of Neural Transmission

Printed in Austria

Serotonin transporter promoter polymorphism genotype is associated with temperament, personality traits and illegal drugs use among adolescents

G. Gerra[1], L. Garofano[2], L. Castaldini[1], F. Rovetto[3], A. Zaimovic[1], G. Moi[1], M. Bussandri[1], B. Branchi[1], F. Brambilla[1], G. Friso[4], and C. Donnini[4]

- Decreased expression of the gene encoding the serotonin transporter in drugs experiment, particularly in higher aggressive and NS.

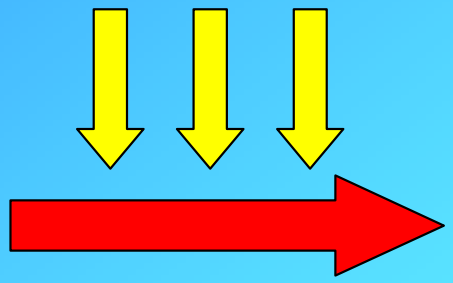
Conclusion Personality, the Brain and Addiction

Diathesis-stress hypothesis of addiction

Stress factors

Neglect and abuse, social deprivation, poor parenting, adverse stressful life events during childhood (PTSD)

Genetic neurobiological temperamental vulnerability



Addiction

Progress in Neurobiology 92 (2010) 572–592

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Progress in Neurobiology

journal homepage: www.elsevier.com/locate/pneurobio

Prevention and treatment of drug addiction by environmental enrichment

Marcello Solinas *, Nathalie Thiriet, Claudia Chauvet, Mohamed Jaber

Institut de Physiologie et Biologie Cellulaires, Université de Poitiers, CNRS 6187, Pôle Biologie-Santeé, 1 Rue George Bonnet, Bat 633, Poitiers 86022, France

- **REDUCING ENVIRONMENTAL STRESS:**

- Training for parents
- Family program
- Training for teachers
- Personalized educational plans
- School/Family efforts integration

Conclusion Personality, the Brain and Addiction

- **Dealing with difficult temperaments and personality traits could be included in strategies of prevention and treatment of drug addiction**

Targeting youth particularly at risk

- Early detection and treatment for children with behavioural disorders.
- Structured leisure time activities.
- Improve the ability of the family to provide physical and emotional care.
- Improve youth's opportunities in the labour market.
- Risk minimizing, protection enhancement
- Change the trajectory of vulnerable children and adolescent

Thank you!!!