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Neurobiological research is expanding our understanding of the biological roots and influences associated with pathological gambling behavior. Several neurotransmitters have been implicated in the development of pathological gambling (PG). In a recent review of the literature, Ibáñez, Blanco and Sáiz-Ruiz (2002) examined the research supporting each of the more popular theories of pathological gambling. This WAGER presents a summary of their work in table 1 below.

Table 1. Neurobiological Hypotheses of Pathological Gambling with Supporting Empirical Evidence

Hypothesis	Supporting Evidence
Serotonergic System PG is an impulse control disorder resulting from a dysfunction in the serotonergic system.	Stimulating the serotonin pathway resulted in lower hormonal response in pathological gamblers as compared to healthy controls (Moreno, Sáiz-Ruiz, & Lopez-Ibor, 1991)
	Two studies have suggested that pathological gamblers have a primary serotonin deficit (Blanco, Oresanz-Munez, Blanco-Jerez, & Sáiz-Ruiz, 1996; Carrasco, Sáiz-Ruiz, Hollander, Cesar, & Lopez-Ibor, 1994).
	Therapeutic trials suggest drugs that enhance the serotonergic pathway are superior to placebos in treating pathological gamblers (Hollander et al., 1998; Hollander, DeCaria, Finkell et al., 2000)
Noradrenergic System PG is a result of higher levels of arousal and sensation seeking resulting from noradrenergic dysfunction.	Pathological gamblers were found to have higher levels of urinary noradrenergic output, cerebral spinal fluid (CSF) noradrenaline, and CSF 3-methoxy-4-hydroxyphenylglicol than healthy controls (Bergh, Eklund, Sodersten, & Nordin, 1997; Roy et al., 1988)
	Stimulating the noradrenergic pathway resulted in elevated levels of hormone response in pathological gamblers indicating high noradrenergic activity (DeCaria et al., 1997)
Dopaminergic System PG is an addictive behavior and therefore has similar pathophysiological mechanisms to other addictions; previous work in the addictions has implicated dopamine.	An urge to gamble activates the same neural pathways in problem gamblers as a drug-craving does in cocaine-dependent subjects (Potenza, Steinberg, Lacadie et al., 2000)
	Measures of CSF dopamine levels and dopamine metabolites indicate a higher release of dopamine in pathological gamblers (Bergh et al., 1997)

Researchers have been investigating the role of genes in the development of PG generally and in the various pathways specifically. Studies of the first degree relatives and twins of pathological gamblers have found evidence of a genetic link (Eisen, Lin, Lyons et al., 1998; Ibáñez, 1997). Readers interested in more information about family studies should see WAGER 7(9). A next step in this program of neurogenetic research will be to isolate the genes that contribute to PG. Genetic research currently focuses on the serotonergic and dopaminergic genes because research indicates these influences are involved in PG. Preliminary genetic studies found that male pathological gamblers are more likely to carry a less functional allele variant for a serotonin transport gene (Comings, Rosenthal, Lesieur et al., 1996). This finding was not replicated in female pathological gamblers; however, women are more likely to carry a less functional allele variant for a receptor in the dopaminergic pathway (Perez de Castro et al., 1997). These findings suggest that genetic contributions might be gender-related.

With each scientific step forward, we gain a better understanding of pathological gambling and the etiological factors associated with its development. The body of research summarized above moves us closer to identifying the neurological pathways and associated genes that contribute to PG. Ultimately, these findings might enable an improved understanding of other behavioral disorders and lead to the development of more effective biological therapies for PG and other disorders.

Comments on this article can be addressed to Rachel Kidman.

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