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Measurement of Impulsivity in a Hierarchical Model of Personality Traits: Implications for Substance Use

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ABSTRACT

This review describes how measures of a prominent three-dimensional hierarchical model of personality traits relate to substance use. H. J. Eysenck proposed a biologically based model of personality that gave rise to related models such as those of J. A. Gray, C. R. Cloninger, and M. Zuckerman. The varying role of impulsivity—a trait related to disinhibition, approach motivation, novelty seeking, and sensation seeking—in successive self-report measures of this model, including the Eysenck Personality Inventory (EPI) and Eysenck Personality Questionnaire (EPQ),

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is described. It is argued that certain findings in experimental, cross-sectional, and longitudinal research using these measures point to the importance of impulsivity as a temperamental vulnerability factor for substance use.

Key Words: Personality trait; Impulsivity; Disinhibition; Approach motivation; Novelty seeking; Sensation seeking; Risk factor; Vulnerability.

This article reviews the evidence regarding the psychometric properties and substance use correlates of measures of the biologically based personality model developed by Hans J. Eysenck (1). One primary dimension of personality that is included in these measures is impulsivity. Because the hypothesis that impulsivity is a risk factor for substance use has been largely substantiated by the studies reviewed in this article, it is important to measure impulsivity. It may also be important to take impulsivity into account in the prevention and treatment of substance abuse.

The argument proceeds as follows. First, Eysenck's hierarchical model of personality is described and compared to related models. Second, the measurement of Eysenck's model using two self-report questionnaires, the Eysenck Personality Inventory (EPI) (2) and the Eysenck Personality Questionnaire (EPQ) (3), is described and compared to related measures. Third, the possible causal importance of impulsivity in research on substance use is described. Based on this review, the use of Eysenck's measures is recommended, with particular emphasis on scales related to impulsivity.

Biologically Based Theories of Personality Traits

Eysenck conceptualized personality as three biologically based traits of temperament: extraversion, neuroticism, and psychoticism (1). Extraversion is characterized by being outgoing, talkative, high on positive affect, and in need of external stimulation. According to Eysenck's arousal theory of extraversion, there is an optimal level of cortical arousal, and performance deteriorates as one becomes more or less aroused than this optimal level. Thus, at very low and very high levels of arousal, performance is low, but at a more optimal midlevel of arousal,

performance is maximized[a]. Extraverts, according to Eysenck's theory, are chronically under-aroused and bored and are therefore in need of external stimulation to bring them up to an optimal level of performance. Introverts, on the other hand, are chronically over-aroused and jittery and are therefore in need of peace and quiet to bring them up to an optimal level of performance.

Neuroticism is characterized by high levels of negative affect such as depression and anxiety. Neuroticism, according to Eysenck's theory, is based on activation thresholds in the sympathetic nervous system or visceral brain (1). This is the part of the brain that is responsible for the fight-or-flight response in the face of danger. Neurotic people, who have low activation thresholds, experience negative affect (fight-or-flight) in the face of relatively minor stressors—they are easily upset. Emotionally stable people, who have high activation thresholds, experience negative affect only in the face of very major stressors—they are calm under pressure. Neuroticism, the disposition to experience negative affect, can be distinguished from negative affect itself, in that those disposed to experience negative affect (e.g., anxiety) may tend to avoid situations that cause it.

Psychoticism is characterized by toughmindedness, nonconformity, hostility, and impulsivity (1). The physiological basis suggested by Eysenck for psychoticism is testosterone, with higher levels of psychoticism associated with higher levels of testosterone.

Eysenck's theory has theoretical and practical value because it specifies some of the biological mechanisms believed to underlie personality traits that have been posited to be risk factors for substance use. Eysenck's theory is also significant because it has inspired other noteworthy biologically based theories, such as those of J. A. Gray (4), C. R. Cloninger (5), and M. Zuckerman (6). All of these theories converge on the importance of impulsivity as related to substance use—sometimes using different names for impulsivity, such as *behavioral approach* (Gray), *novelty seeking* and *reward dependence* (Cloninger), and *sensation seeking* (Zuckerman). (A brief glossary of terms used in this article appears in Table 1.) Despite minor differences, these theories are representative of a family of related biological models that took Eysenck's theory as their starting point.

[a]Such *arousal* in the cortico-reticular loop should not be confused with *activation*, or autonomic arousal in the visceral brain. Although these two systems typically act in relative independence, strong activation (fight-or-flight) will also bring about arousa (1).

Table 1. Definitions of key terms.

Approach motivation—tendency to seek out pleasant stimuli.
Behavioral Approach System (*BAS*)—brain system posited to underlay the tendency to seek out pleasant stimuli.
Behavioral Inhibition System (*BIS*)—brain system posited to underlay the tendency to avoid unpleasant stimuli.
Disinhibition—tendency to act without regard for consequences.
Impulsivity—personality trait characterized by acting on impulse, nonplanning, liveliness, and risk-taking.
Novelty seeking—tendency to seek out-of-the-ordinary experiences.
Reward dependence—approach motivation.
Risk factor—characteristic that increases the probability of a particular outcome.
Sensation-seeking—tendency to seek exciting experiences.
Trait—stable, cross-situational individual difference.
Vulnerability—increased probability of a particular outcome.

Gray (4) proposed a neuropsychologically based two-dimensional model of personality and motivation with the trait of impulsivity being based on an appetitive behavioral approach system (BAS) and the trait of anxiety being based on an avoidance behavioral inhibition system (BIS). Impulsivity in Gray's model is closely related to extraversion in Eysenck's model, whereas anxiety in Gray's model is closely related to neuroticism in Eysenck's model (4).

Cloninger (5) proposed a three-dimensional model of personality based on neurogenetic adaptive mechanisms, with dimensions of novelty seeking, reward dependence, and harm avoidance. The first two traits appear on conceptual grounds to be nearly equivalent to Gray's BAS, whereas the latter appears to be nearly equivalent to Gray's BIS (7).

Zuckerman (6) introduced the trait of sensation seeking based on a comparative approach. He observed that, in both humans and nonhuman animals, sensation seeking appeared to be genetically determined and have common biological correlates (e.g., high levels of gonadal hormones, monoamine oxidase, and augmenting of cortical-evoked potential). Sensation seeking is similar to dimensions related to impulsivity in Eysenck's and Cloninger's models (8–9).

Eysenck's theory remains influential; before his death in 1997, he was the most cited living psychologist, and he is the third most cited psychologist of all time, after Freud and Piaget (10). Eysenck's biological conceptualization of personality stands in stark contrast to Freud's

dynamic conceptualization, however, of which Eysenck was an early and vocal critic (11). For example, Eysenck would not have countenanced the idea that resistance is at fault for avoiding substance abuse treatment; instead, he tried to specify relatively stable characteristics of temperament that predispose individuals to initiate and continue substance abuse.

Because the literature on impulsivity and other traits related to disinhibition is huge, this review focuses on impulsivity as measured specifically by instruments designed to represent Eysenck's personality theory. This theory has not remained static but has developed over time; with it have changed the associated measuring instruments. The correlates of these measures also differ in important ways. One major goal for this article is to elucidate the varying substance use correlates of these assorted measures.

A Hierarchical Model of Personality Description

Eysenck's model of personality and its associated measures are hierarchical (1). A hierarchical model is one in which items at the first level are factor analyzed to derive factors at the second level, these factors are factor analyzed to derive factors at the third level, and so on. At the first level of Eysenck's hierarchy are *behaviors*, including responses to questionnaire items. At the second level are collections of behaviors, called *habits*. At the third level are collections of habits, called *traits*. At the fourth level are collections of traits, called *types*; the latter might also be called *global* personality traits. The EPI measures two global personality traits, extraversion (E, as contrasted with introversion) and neuroticism (N, as contrasted with emotional stability). The two traits that make up EPI extraversion are impulsivity and sociability. Although these two traits are positively correlated in the EPI, they show varying patterns of associations with external criteria (e.g., cognitive performance under the influence of caffeine, described below). The EPQ was developed to represent a further refinement of Eysenck's theory of personality. It includes three global personality traits at the highest level of the hierarchy—psychoticism, extraversion, and neuroticism—and thus represents what has been called the PEN model.

Differences in the way impulsivity has been conceptualized and measured in the EPI and EPQ are important for the theory of personality and its relation to substance use, because impulsivity is related empirically to substance use. The dimensionality of these two instruments differs with respect to extraversion (12). In the EPI, extraversion is made

Table 2. Example impulsivity items from the Eysenck personality inventory.

Item number	Item
1	Do you often long for excitement?
3	Are you usually carefree?
5	Do you stop and think things over before doing anything? (R)
8	Do you generally do and say things quickly without stopping to think?
10	Would you do almost anything for a dare?
13	Do you often do things on the spur of the moment?
22	When people shout at you, do you shout back?
39	Do you like doing things in which you have to act quickly?
41	Are you slow and unhurried in the way you move? (R)

Note: (R) indicates reverse-scored items.

up of the dual components of impulsivity and sociability. In the EPQ, extraversion is made up of sociability alone. The content of the EPI and EPQ also differs with respect to psychoticism. In the EPI, there is no psychoticism scale. In the EPQ, psychoticism includes some impulsivity items from EPI extraversion (1). Impulsivity in Eysenck's system is a combination of four basic habits: (a) narrow impulsivity, (b) nonplanning, (c) liveliness, and (d) risk-taking (13). Example impulsivity items are listed in Table 2.

Other Self-Report Measures of Constructs Related to Impulsivity

Other measures have been developed that include scales related conceptually and empirically to impulsivity. These include the BIS/BAS Scales, the Tridimensional Personality Questionnaire (TPQ), and the Sensation Seeking Scales (SSS). Unfortunately, each of these measures has problems that make it less than optimal for research on personality traits in relation to substance use, as compared with Eysenck's measures.

The BIS/BAS Scales (7) were developed to provide a self-report measure of Gray's (4) theory of personality traits. One problem with

the scales devised is that rather than a single BAS scale to index phenomena related to impulsivity, this measure includes three BAS scales (BAS reward responsiveness, BAS drive, and BAS fun seeking).

The TPQ (5) was developed to assess Cloninger's three-dimensional model of personality traits: novelty seeking, reward dependence, and harm avoidance. Unfortunately, the content of a number of the items is ambiguous as to whether it indicates novelty seeking or reward dependence. In addition, the latter two scales have been shown not to form internally consistent second-order factors (14).

The SSS (15) was developed to assess Zuckerman's model of personality traits related to impulsive unsocialized sensation seeking, of which the most relevant is the disinhibition subscale. Unfortunately, this subscale includes items that explicitly ask about alcohol use. Thus, it is not surprising that items that ask about substance use predict substance use—such criterion-contamination makes use of the SSS to predict substance use problematic (16).

The EPI and EPQ have several strengths that make them worthwhile measures for the assessment of personality traits as related to substance use. The Eysenck measures are important because they (a) are based on a well-developed theory of personality traits (1), (b) have been available for decades and are widely used, (c) converge with other measures that are widely used (8,9), (d) do not suffer from defects that afflict other measures, such as criterion-contamination (i.e., no items ask about substance use), and (e) have been translated into several languages (17). Thus, it makes sense to examine the relation between the Eysenck measures and substance use.

Experimental Research on Impulsivity and Substance Use

Interesting patterns of relations have been documented between impulsivity in Eysenck's personality measures, substance use, and related variables such as attitudes toward substance use. The importance of impulsivity for substance use has been shown in experimental, cross-sectional, and longitudinal research using the Eysenck measures. Some of this research is described below (see Table 3).

Experimental research using the Eysenck measures has shown the importance of impulsivity for substance use. For example, one study showed that impulsivity is inversely related to serotonin levels in older adolescents with alcohol use disorders (18). Moreover, EPQ psychoticism is correlated with physiological measures (e.g., heart rate), drinking

Table 3. Study characteristics.

Authors	Location of sample	*N*	Measure	Trait(s)	Drug(s)	Type of study
Canals et al. (1997)	Reus, Spain	290	JEPQ	P, E, N	Tobacco	Longitudinal
Conrod et al. (1997)	Montreal, Canada	30	EPQ	P	Alcohol	Experimental
Cooper et al. (2000)	Buffalo, NY	1,814	Various items	E, N, Imp	Alcohol	Cross-Sectional
Foreyt et al. (1993)	Texas	1,637	EPI	E, N, L	Tobacco	Cross-Sectional
Francis (1997)	England and Wales	11,173	JEPQ	P, E, N, L	Attitudes toward substance use	Cross-Sectional
Grau & Ortet (1999)	Castello, Spain	149	EPQ-R	P, E, N, L	Alcohol	Cross-Sectional
Heath et al. (1997)	Australia	5,889	EPQ	P, E, N, L	Alcohol	Cross-Sectional
Kawakami et al. (2000)	Takayama, Japan	136	EPQ	P, E, N, L	Tobacco	Cross-Sectional
LoCastro et al. (2000)	Boston, MA	485	EPI	N, Imp, Soc	Alcohol	Longitudinal
Ozkaragoz & Noble (2000)	Los Angeles, CA	119	JEPI	E, N	Alcohol	Cross-Sectional
Patton et al. (1993)	Winnipeg, Canada	1,257	EPQ-R	P, E, N, L	Tobacco	Cross-Sectional
Patton et al. (1997)	Winnipeg, Canada	346	EPQ-R	P, E, N, L	Tobacco	Cross-Sectional
Revelle et al. (1980)	Evanston, IL	629	EPI	E, Imp, Soc	Caffeine	Experimental
Sher et al. (2000)	Columbia, MO	457	EPQ	P, E, N	Alcohol, tobacco, any other	Longitudinal
Soloff et al. (2000)	Pittsburgh, PA	36	I-6	Imp	Alcohol	Experimental

Note: EPQ = Eysenck Personality Questionnaire. EPQ-R = Revised Eysenck Personality Questionnaire. JEPQ = Junior Eysenck Personality Questionnaire. EPI = Eysenck Personality Inventory. JEPI = Junior Eysenck Personality Inventory. I-6 = Eysenck Impulsiveness Questionnaire (version 6). P = Psychoticism. E = Extraversion. N = Neuroticism. L = Lie. Imp = Impulsivity. Soc = Sociability.

behavior in the lab, and self-reported drinking (19). These finding suggest that impulsivity may be a temperamental vulnerability factor for alcoholism.

Caffeine has an effect on cognitive performance that is mediated by EPI impulsivity but not sociability (20). This relation can be assessed by items in the EPI extraversion scale but not in the EPQ extraversion scale, because the impulsivity items in the former are absent in the latter. Impulsivity thus appears to be the operative element in Eysenck's arousal theory of extraversion according to which extraverts are chronically underaroused and in need of external stimulation in order to achieve optimal performance. The patterns of experimental findings for alcohol and caffeine are consonant with the interpretation that impulsivity rather than sociability is a causal influence on substance use.

Cross-Sectional Research on Impulsivity and Substance Use

Cross-sectional research using the Eysenck measures has shown the importance of impulsivity for substance use. One study (21) found in a large sample of 13–15-year-old pupils in the United Kingdom that each scale of the Junior Eysenck Personality Questionnaire (JEPQ) was correlated with attitudes toward substance use. The most tolerant attitudes toward substance use were held by pupils who were (in descending order of association magnitude) toughminded (high on psychoticism), socially nonconforming (low on the lie scale), extraverted (high on extraversion), and emotionally stable (low on neuroticism). The fact that psychoticism was the most strongly related to attitudes toward substance use is interesting, because, in the JEPQ, impulsivity falls under psychoticism. In other words, it is clear that impulsivity plays an important role in attitudes toward substance use among adolescents. The Francis (21) study is even more impressive in light of the fact that the psychoticism effect was necessarily attenuated due to a fairly unreliable psychoticism scale, which has an average alpha reliability across all studies of 0.68 (22).

In cross-sectional analyses on a large-scale community sample of adolescents, impulsivity alone had little direct effect on heavy drinking or drinking-related problems. The combination of high impulsivity and high surgency (the latter being composed primarily of items reflecting social dominance and positive emotionality) made aversive motives for drinking (i.e., drinking to cope with negative emotions) more

influential (23). Thus, impulsivity has an indirect interaction effect on heavy drinking and drinking-related problems.

Cross-sectional analyses on a sample of 149 Spanish nonalcoholic women documented positive correlations between alcohol consumption and impulsivity-related traits as measured by the revised EPQ (24). Among the personality traits studied, impulsivity and sensation seeking were the strongest correlates of alcohol consumption, whereas neuroticism was not correlated with alcohol consumption.

In analyses on the Australian Twin Registry, risk for a *DSM-III-R* diagnosis of alcohol dependence was associated with being in at least the 75th percentile on EPQ psychoticism in men but not in women (25). Risk for alcohol dependence was also associated with EPQ neuroticism and the EPQ lie scale, a measure of socially desirable responding, in both men and women (25).

Minor alleles of the D2 dopamine receptor are associated with higher extraversion scores on the Junior Eysenck Personality Inventory in children who live in an alcoholic as opposed to a nonalcoholic home (26) (note that such home environments might have been associated with a diversity of drinking patterns). This finding further points toward impulsivity as an environmentally mediated temperamental risk factor for alcoholism.

In a large random sample of adults, smokers were found to be high on EPQ psychoticism (27). In another sample, men who use smokeless tobacco were found to score higher than nonusers of tobacco on EPI extraversion and neuroticism, with elevated scores specifically on impulsivity (28). These results are consistent with an important role for impulsivity in tobacco use.

In addition to the cross-sectional research on Eysenck's measures of impulsivity, there is cross-sectional research documenting that neuroticism in the revised EPQ is an important correlate of nicotine dependence (29). Smoking cigarettes may help neurotic persons to lessen the feeling of stress, to which they are thought to be particularly vulnerable (30). Given that smoking is associated with depression (31), and depression is a core feature of neuroticism, the latter findings on smoking provide evidence consistent with Eysenck's theory.

Longitudinal Research on Impulsivity and Substance Use

Longitudinal research using the Eysenck measures has shown the importance of impulsivity for substance use. One study of Spanish

adolescents tested at age 10–11 and followed up at age 18 found JEPQ psychoticism to be the personality dimension that best predicts smoking and nicotine dependence (32). The association between psychoticism and smoking may be mediated by either the serotonergic system (33,34) or the dopamine system (35).

In a large-scale study of young adults, Sher, Bartholow, and Wood (36) found that each of the temperament dimensions measured by the EPQ (P, E, and N) was correlated cross-sectionally with *substance use disorders* (diagnosed using the Diagnostic Interview Schedule). Longitudinal analyses performed six years later indicated that psychoticism but not extraversion or neuroticism predicted the presence of *substance use disorders* (any). Specifically, psychoticism predicted *alcohol dependence*. Psychoticism did not predict tobacco abuse or dependence, nor did it predict drug abuse or dependence. The authors noted that the lack of findings in this study emerged after statistically controlling for baseline diagnosis, which makes for conservative estimates of effect size.

In the VA Normative Aging Study (37), a large-scale longitudinal study on substance use in older adults, EPI impulsivity did not predict alcohol use or alcohol use-related problems. This anomalous finding with respect to the importance of impulsivity for substance use may be due to intrinsic differences in impulsivity between young adults and older adults. Alternatively, it could be explained in terms of cross-sectional findings discussed above on the interaction of impulsivity, surgency, and aversive motivation (23). Specifically, higher extraversion (both impulsivity and surgency) leads to more drinking for aversive reasons—that is, drinking to cope. The latter finding favors an important role for motivational states (e.g., aversive/coping and appetitive/ enhancement) in determining the effect of personality traits on substance use (23).

Summary and Implications

This review has argued that impulsivity is a temperamental risk factor for substance use. It is therefore important to measure impulsivity and to measure it well. Eysenck's measures, including the EPI and EPQ, are important in part because they are widely used and have shown systematic relations to substance use. In addition, these measures are important because they are based on a well-developed theory of the physiological bases of personality traits, and because they have stood the test of time.

Although Eysenck's theory of personality is highly regarded, there are others, such as those of Gray, Cloninger, and Zuckerman. All of these theories converge on the importance of impulsivity, but Eysenck's was the earliest and one of the most studied. Eysenck's impulsivity measures are highly correlated with impulsivity-related measures of other personality theorists (8,9). Thus, Eysenck's measures may be thought of as a surrogate for the measures developed by other theorists who emphasize the role of impulsivity.

Given the importance of impulsivity, it may be advisable for substance use researchers to assess impulsivity using measures such as (a) the impulsivity subscale that is part of the EPI extraversion scale or (b) the EPQ psychoticism scale, which includes many impulsivity items. Because the EPI impulsivity subscale can be scored separately from the sociability subscale and the broader extraversion scale (which includes both impulsivity and sociability), it may be more convenient to study impulsivity using the EPI rather than the EPQ.

One reason for the importance of impulsivity may be its evolutionary basis. Suomi (38) showed that rhesus monkeys who exhibited novelty-seeking behavior by examining an unfamiliar object dropped into their midst were more likely to drink alcohol. Although direct comparisons between monkeys and humans should be made with caution, this finding suggests that impulsivity is an evolved trait of temperament that has implications for substance use.

Impulsivity may be important in both the research and prevention of substance use. With regard to prevention, for example, advertisements targeted at impulsive adolescents, who are at risk for becoming users of illicit substances, could emphasize—and have emphasized—the thrill and excitement of activities other than substance use, such as extreme sports (39). Although such targeted interventions have yet to become widely popular and empirically validated, they could prove more effective than interventions that do not take personality into account.

Future research directions include the following. First, although impulsivity has been studied in the context of diverse cultures, further research into its possible cultural boundedness would be beneficial. Second, research into the possible applications of impulsivity to the prevention of substance abuse would be beneficial. Third, further research could shed light on the relation between impulsivity in substance users who no longer use illicit substances but do use legal ones (e.g., tobacco). Fourth, research could clarify whether there is a type of individual who is very low on impulsivity and as a consequence does not use any chemical substances.

The present review was intended to clarify the role of Eysenck's measures of impulsivity for understanding substance use. Impulsivity not only has long been considered important for substance use but also has been shown to be important by the studies reviewed in this article. Experimental, cross-sectional, and longitudinal studies using Eysenck's personality measures converge on the conclusion that impulsivity is an important risk factor for substance use.

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RESUMEN

Esta reseña describe la forma en que las medidas de un prominente modelo tridimensional jerárquico de rasgos de personalidad se relaciona con el uso de sustancias. H. J. Eysenck propuso un modelo biológico de la personalidad que dio lugar al desarrollo de modelos relacionados, tales como el de J. A. Gray, C. R. Cloninger y M. Zuckerman. En este artículo se describe la variedad de roles de la impulsividad—un rasgo relacionado con la deshinbición, la motivación hacia cosas placenteras, la búsqueda de la novedad y las nuevas sensaciones—dentro de sucesivas mediciones de autoreporte de este modelo, incluídas las descripciones del Inventario de Personalidad de Eysenck (EPI) y del Cuestionario de Personalidad de Eysenck (EPQ). Se ha argumentado que ciertos descubrimientos en investigaciones experimentales, transversales y longitudinales en que se han utilizado estas medidas destacan la importancia de la impulsividad como un factor de la vulnerabilidad temperamental para el uso de sustancias.

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RÉSUMÉ

Cet article concerne les mesures d'un modèle hiérarchique majeur à trois dimensions de la personnalité et décrit comment ces mesures sont liées à l'ingestion de substances. H. J. Eysenck a proposé une modélisation de la personnalité qui'il a basée sur la biologie. Cette modélisation a inspiré celles de J. A. Gray, C. R. Cloninger, et M. Zuckerman. L'article inclut une description des rôles variables de l'impulsivité, un trait de caractère lié a la désinhibition, approche de la motivation, recherche de nouveauté, recherche de sensation, au moyen de rapports successifs d'auto-évaluation de ce modèle, incluant l'Inventaire de Personnalite de Eysenck (EPI) et le Questionnaire de Personnalite de Eysenck (EPQ). La thèse defendue ici est que certaines recherches de type expérimental, coupe transversale et longitudinal faisant usage de ces mesures soulignent l'importance de l'impulsivité en tant que facteur rendant plus vulnérable à l'utilisation de substa.

THE AUTHOR

After receiving his Ph.D. in psychology from Northwestern University, G. Scott Acton moved to the University of California, San Francisco, where he has conducted research on smoking and depression. Dr. Acton is interested in the measurement of individual differences generally, including those in psychopathology and intelligence as well as in personality and substance use.

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