Recreational Use of Erectile Dysfunction Medications and Its Adverse Effects on Erectile Function in Young Healthy Men: The Mediating Role of Confidence in Erectile Ability

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ABSTRACT

Introduction. Oral erectile dysfunction medications (EDMs) have become an increasingly popular drug of abuse among young men without a medical indication. In addition to being associated with increased sexual risk behaviors, recreational EDM use may adversely impact psychological aspects of sexual function, primarily by affecting one's confidence in pharmacologically unaided erectile ability. To date, these associations have not been investigated empirically.

Aim. This study examined the mediating role of confidence in erectile ability on the concurrent relationship between recreational EDM use and erectile function among young healthy men. A secondary aim was to examine erectile function characteristics among recreational users, prescribed users, and nonusers to control for the possibility that recreational users were using EDMs to treat ED.

Methods. The sample comprised 1,207 sexually active men (mean age = 21.9 years; standard deviation = 4.48) who were recruited from undergraduate institutions within the United States.

Main Outcome Measures. Participants completed an online survey assessing frequency of EDM use, as well as levels of sexual function (erectile function, orgasmic function, sexual desire, intercourse satisfaction, and overall sexual satisfaction) and levels of confidence in ability to gain and maintain erection, as per the International Index of Erectile Function.

Results. Recreational users (N = 72) reported similar erectile function levels compared with nonusers (N = 1,111), and both groups differed from prescribed users (N = 24). Recreational users also reported lower erectile confidence and lower overall satisfaction compared with nonusers. Results were consistent with mediation, in that more frequent EDM use was inversely associated with erectile confidence, which in turn showed negative relations with erectile function.

Conclusions. Confidence in erectile abilities mediates the inverse relationship between recreational EDM use and erectile function. Results underscore the possibility that recreational EDM use among healthy young men may lead to psychogenic ED. Additional longitudinal research is necessary to establish a causal link between these variables.

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Key Words. Erectile Dysfunction; Psychogenic Sexual Dysfunction; Erectile Function in Young Men; Erectile Dysfunction Medication; Recreational Use; Sildenafil; Confidence in Erectile Ability

Introduction

Erectile dysfunction (ED) is a relatively common medical problem and is estimated to affect 34 million men in the United States and more than 150 million men worldwide [1,2]. ED is age associated, with prevalence rates ranging from 5% to 9% for men 18–39 years, 11–18% for men 40–59 years, and 44–70% for men 60 years and older [3,4]. There are currently three Food and Drug Administration-approved oral medications for the treatment of ED (sildenafil [Viagra, Pfizer, Inc., New York, NY, USA], tadalafil [Cialis, Lilly, ICOS, Indianapolis, IN, USA], and vardenafil [Levitra and Staxyn, GlaxoSmithKline, Brentford, Middlesex, UK]), and these are all effective and well tolerated for treating ED of various etiologies [5,6]. For these reasons, the World Health Organization recommends oral ED medications (EDMs) as the first-line treatment for ED [7]. These medications have been used extensively since their release, and it is estimated that over 40 million prescriptions have been issued worldwide for sildenafil alone [8].

The effectiveness and ease of use of EDMs have made them an increasingly popular drug of abuse among men without a medical indication. This has raised public health concerns, as recreational EDM use has been associated with increased sexual risk behaviors. In fact, studies demonstrate that recreational EDM users report higher rates of unprotected intercourse [9], higher number of recent sex partners [10,11], and present with elevated rates of sexually transmitted infections [10,12].

Relatively less attention has been given to the potential adverse psychological effects resulting from recreational EDM use. Frequent use of EDMs may engender unreasonable expectations with respect to erectile performance in terms of frequency, spontaneity, rigidity, and duration of erections. For example, men may begin to believe that erections should occur immediately and automatically in response to sexual stimuli and/or that they should always maintain rigidity until orgasm [13]. As such, sexual performance anxiety may develop as a result of reduced confidence in one's ability to acquire and maintain these standards of erectile ability without the use of an EDM.

To date, only one study has empirically investigated this phenomenon. In a population-based study of 4,428 Finnish men, Santtila and colleagues [13] found that recreational EDM users reported significantly decreased erectile confidence compared with nonusers, and these levels were similar to those reported by individuals using EDMs prescribed by a physician to treat ED. Additionally, the authors noted that recreational users reported erectile function (EF) levels tantamount to nonusers, suggesting that recreational users were not simply underreporting clinically salient erectile difficulties. Taken together, the authors posited that chronic recreational use of EDMs has the potential to introduce psychogenic ED by deleteriously affecting one's confidence in pharmacologically unaided ability to gain and maintain erection.

A theoretical pathway from recreational EDM use to reduced erectile confidence and ultimately to increased physiological ED symptoms makes intuitive sense and, if shown empirically to be the case, would have important clinical implications. However, to date, these associations have not been subjected to a statistical model capable of adequately delineating these interrelationships (i.e., the mediating role of self-efficacy in erectile abilities on the association between recreational EDM use and ED symptoms).

Aim

The present study attempted to build upon the relatively underexplored literature of the adverse psychological effects of recreational EDM use by examining the mediating role of erectile confidence among a national cross-sectional sample of young healthy men within the United States. The intentional sampling of undergraduate students provided leverage against the potential confounding effects of clinically significant age-related ED symptoms. A secondary aim was to explore EF characteristics among recreational EDM users, prescribed EDM users, and nonusers, with the intention of contextualizing recreational EDM users. That is, we attempted to rule out the possibility that recreational users were displaying a profile more consistent with prescribed users (acquiring EDMs illicitly, but to treat clinically salient ED symptoms).

Method

Study Population, Subject Recruitment, and Data Collection

Data presented herein were taken from a national cross-sectional convenience sample of 1,944 undergraduate men within the United States recruited between 2006 and 2007 [14]. Participants used in these secondary analyses consisted of

Table 1 Characteristics of the participant sample (N = 1,207)

Characteristic	*M*	SD	N	%
Age (years)	21.9	4.48		
Race/ethnicity*				
White/Caucasian			862	73.2
African American/black			54	4.6
Hispanic/Latino			120	10.2
Asian			118	10.0
American Indian/Alaskan Native			6	0.5
Other			17	1.4
Education (years)	14.7	1.16		
Sexual identity				
Heterosexual/straight			1,023	84.8
Homosexual/gay			156	12.9
Bisexual			28	2.3
Current romantic relationship			735	60.9
Sexual function†				
Erectile function	27.7	4.04		
Orgasmic function‡	8.9	1.82		
Sexual desire	8.1	1.57		
Intercourse satisfaction§	11.5	2.99		
Overall satisfaction	7.8	2.00		
EDM use (during past 4 weeks)				
Recreational use			72	6.0
Prescribed use			24	2.0
No use			1,111	92.0
Alcohol use¶	6.1	2.84		

*Racial/ethnic data were missing for 30 participants
†As per the International Index of Erectile Function [16]
‡Data missing for one participant
§Data missing for two participants
¶Assessed with the alcohol consumption questions of the Alcohol Use Disorders Identification Test [15]. Possible scores range from 0 to 12 with higher scores representing increased problematic drinking
EDM = erectile dysfunction medication; SD = standard deviation

a subsample of 1,207 men, all of whom were sexually active and provided self-report data pertaining to erectile functioning and use of EDMs. Participants also provided demographic data, as well as information pertaining to alcohol use (assessed by the three alcohol consumption questions of the Alcohol Use Disorders Identification Test) [15]. The sample had a mean age of 21.9 years (standard deviation [SD] = 4.48), and the majority of participants had a regular sexual partner (61%) and were unmarried (95%). Characteristics of the participant sample are presented in Table 1.

Full details regarding recruitment and data collection are described elsewhere [14]. In brief, male participants aged 18 and older were recruited both online and via an undergraduate psychology subject pool and were asked to participate in a survey on "sexual behavior and recreational drug use." Respondents were required to first read an online cover letter describing the nature of the survey. They were informed that the survey would take approximately 30 minutes to complete and that they only had to answer items with which they felt comfortable. To gain access to the anonymous web-based survey, all participants were required to provide electronic informed consent. Acquiring informed consent using these methods is in line with the recommendations of the Board of Scientific Affairs' Advisory Group on the Conduct of Research on the Internet [17]. After completion of the survey, participants read a debriefing letter and were given a random identification number serving as confirmation of survey completion. Respondents were invited to e-mail these identification numbers to the principal investigator such that they could be entered into a raffle. One participant was randomly selected each month and mailed a check for $50. Participants within the psychology subject pool received credit toward their psychology research requirement. The protocol was approved by the University of Texas at Austin Institutional Review Board.

Main Outcome Measures

EDM Use

Participants were asked whether they had used an oral EDM during the previous 4 weeks, and if yes, they reported on the type(s) used (sildenafil, tadalafil, and vardenafil) and dosage of each EDM. Those responding affirmatively were further queried on whether EDM use was for recreational purposes or to treat ED diagnosed by a physician. Respondents also reported the frequency with which they used an EDM, as well as the frequency of EDM use concurrently during sexual intercourse during the previous 4 weeks. This latter value was divided by a respondent's self-reported frequency of intercourse over the prior 4 weeks, resulting in a ratio of EDM use per sexual intercourse occasion.

EF

Sexual functioning within the past 4 weeks was assessed by the International Index of Erectile Function (IIEF) [16]. The IIEF is a 15-item self-report questionnaire assessing five domains of sexual functioning in men: EF (six items; $\alpha = 0.84$), orgasmic function (two items; $\alpha = 0.88$), sexual desire (two items; $\alpha = 0.78$), intercourse satisfaction (three items; $\alpha = 0.68$), and overall satisfaction (two items; $\alpha = 0.87$). The IIEF has been shown to have acceptable internal reliability (Cronbach's alpha values of 0.73 and higher), test–retest reliability ($r = 0.64$ to $r = 0.84$), and validity [16]. For the purposes of the mediational analyses, the erectile confidence question (item 15) was removed from the summed IIEF EF subscore. The result-

ing five-item (items 1–5; $\alpha = 0.84$) subscore represented purely physiological (not psychological) aspects of erectile functioning. Possible scores ranged from 0 to 25, with higher scores indicating superior EF.

Confidence in Erectile Ability

Self-reported confidence in ability to achieve and maintain adequate erections during the past 4 weeks was assessed with item 15 of the IIEF [16]. Participants rated their levels of confidence according to the following response options: 1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high.

Statistical Analysis

General linear modeling (in the form of one-way analysis of covariance models) was used to compare all groups (nonusers, recreational EDM users, and prescribed users) with respect to sexual function and EDM use characteristics. In cases where the overall main effect term was statistically significant, planned comparison *F*-tests with Bonferroni correction (0.05/3 = 0.017) for adjusted cell means were used to assess between-group differences. Age was entered as a covariate in all analyses. Measures of variance (η^2) were calculated according to the guidelines proposed by Cohen [18].

Tests of simple indirect effects were employed with an SPSS (SPSS Inc., Chicago, IL, USA) application developed by Preacher and Hayes [19]. This macro provides a test of the indirect effect (i.e., EDM use on EF though erectile confidence, with age as a covariate), as well as traditional tests of mediation using the Baron and Kenny [20] approach. The application uses a bootstrapping procedure (N = 10,000 bootstrap resamples), which generates a sampling distribution for *ab*. This technique is not dependent on the normality assumption underlying the Sobel [21] test and the causal step approach to mediation proposed by Baron and Kenny [20], resulting in a more sensitive and powerful test of mediation [22]. To assess indirect effects, 95% confidence intervals (CIs) were generated for the parameter estimates. These parameter estimates were considered statistically significant if the CIs did not include zero. Squared semipartial correlations (sr^2) were reported for both the direct and indirect effects to illustrate the reduction in proportion of explained unique variance. In addition to testing indirect effects using the Preacher and Hayes [19] method, results were also presented using Baron and Kenny's [20] approach, given that this technique is still widely in use.

Results

Sexual Function Characteristics

Of the subsample of 1,207 sexually active men, 92% (N = 1,111) reported never using an EDM, 6% (N = 72) had used EDMs recreationally, and 2% (N = 24) reported being prescribed an EDM by a physician. Associated characteristics of EDM use have been reported previously [14] and shall not be repeated here.

Regarding sexual function characteristics (as per the IIEF), the groups differed in terms of physiological EF (items 1–5 of the IIEF) ($F_{2,1203} = 13.71$, $P < 0.001$, $\eta^2 = 0.02$), with both recreational EDM users ($P < 0.001$) and nonusers ($P < 0.001$) reporting significantly higher physiological EF scores compared with prescribed users. When erectile confidence was examined (item 15 of the IIEF), a different pattern emerged. Specifically, both prescribed ($P < 0.01$) and recreational ($P < 0.01$) EDM users displayed lower erectile confidence compared with nonusers, with the former two groups not differing from one another ($P = 0.14$). There was also a main effect of group for overall satisfaction ($F_{2,1203} = 4.14$, $P = 0.02$, $\eta^2 = 0.01$), with recreational EDM users showing lower levels of overall satisfaction compared with both nonusers ($P < 0.01$) and prescribed users ($P < 0.01$). Groups did not differ with respect to orgasmic function ($F_{2,1203} = 1.87$, $P = 0.08$, $\eta^2 < 0.01$), sexual desire ($F_{2,1203} = 0.23$, $P = 0.80$, $\eta^2 < 0.01$), intercourse satisfaction ($F_{2,1203} = 2.75$, $P = 0.07$, $\eta^2 < 0.01$), or in terms of alcohol usage ($F_{2,1203} = 2.23$, $P = 0.11$, $\eta^2 < 0.01$). Additionally, the groups differed significantly in terms of age ($F_{2,1203} = 29.07$, $P < 0.001$, $\eta^2 = 0.05$). Specifically, both recreational ($P < 0.001$) and prescribed ($P < 0.001$) EDM users were significantly older compared with nonusers; however, recreational and prescribed users did not differ from one another ($P = 0.14$). Finally, recreational and prescribed users did not differ with respect to the rate at which they used an EDM during sexual activity ($F_{1,193} = 1.42$, $P = 0.24$, $\eta^2 = 0.02$). Please see Table 2 for a summary of these data.

Mediation Analyses

Analyses of mediation were conducted only among the subsample of recreational EDM users (N = 72), with age entered as a covariate, EDM use

Table 2 Correlations among study variables and comparisons between recreational EDM users, prescribed EDM users, and nonusers (N = 1,207)

	Variable	1	2	3	4	5	6	7	8	9
1	IIEF-EF total‡		0.99***	0.61***	0.39***	0.23***	0.53**	0.31**	–0.21**	–0.11***
2	Physiological EF§			0.46***	0.35***	0.21***	0.53***	0.28***	–0.24*	–0.12***
3	Erectile confidence¶				0.37**	0.20***	0.28***	0.28***	–0.02	–0.05
4	IIEF—OF					0.19***	0.39***	0.32***	–0.05	–0.03
5	IIEF—SD						0.32***	0.21***	–0.12	–0.06*
6	IIEF—IS							0.60***	–0.25*	–0.06*
7	IIEF—OS								0.10	–0.11***
8	EDM use††									0.17
9	Age									

Nonusers (NUs) (N = 1,111)		Recreational users (RUs) (N = 72)		Prescribed users (PUs) (N = 24)				
M	Standard deviation	*M*	Standard deviation	*M*	Standard deviation	*F*†	η^2	Group comparisons
27.8	3.97	26.8	4.35	23.5	7.03	15.02***	0.02	NU = RU > PU
23.6	3.57	22.6	3.61	19.5	6.63	13.71***	0.02	NU = RU > PU
4.5	0.77	4.2	0.97	3.9	0.96	9.37***	0.02	PU = RU < NU
8.7	1.83	8.4	2.45	8.5	2.23	1.87	<0.01	NU = RU = PU
8.1	1.57	8.2	1.59	8.3	1.58	0.23	<0.01	NU = RU = PU
11.5	3.00	11.1	3.02	10.2	4.58	2.75	<0.01	NU = RU = PU
7.8	2.00	7.1	2.01	7.5	2.00	4.14*	0.01	NU = PU > RU
—	—	0.11	0.24	0.19	0.38	1.42	<0.01	NU = RU = PU
21.7	4.37	24.8	6.08	26.3	6.78	29.07***	0.05	PU = RU > NU

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$
†Multivariate model adjusted for age
‡Total EF subscore (items 1, 2, 3, 4, 5, and 15)
§Physiological EF subscore of the IIEF (items 1, 2, 3, 4, and 5; excludes item 15)
¶Item 15 of the IIEF ("How do you rate your confidence that you can get and keep your erection?")
††Ratio of the number of times a participant used an EDM during sexual intercourse divided by the total intercourse frequency during the past 4 weeks
EDM = erectile dysfunction medication; EF = erectile function; IIEF = International Index of Erectile Function [16]; IS = intercourse satisfaction; OF = orgasmic function; OS = overall satisfaction; SD = sexual desire

inversely predicted confidence in ability to achieve and hold erection ($B = –0.26$, $SE = 0.13$, $P = 0.05$), and erectile confidence positively predicted EF ($B = 8.29$, $SE = 1.28$, $P < 0.001$) (see Table 3). Furthermore, the indirect effect of EDM use through erectile confidence was significant, as indicated by 95% CIs not containing a value of zero (CI = –5.83, –0.02). When the effect of EDM use on EF was controlled, the direct effect was reduced from statistical significance ($B = –3.62$, $SE = 1.75$, $P = 0.04$, $sr^2 = 0.05$) to nonsignificance ($B = –1.46$, $SE = 1.43$, $P = 0.31$, $sr^2 = 0.006$), suggestive of complete mediation [20].

To strengthen the interpretation of the above mediational analyses, we conducted an additional analysis reversing the mediator and dependent variables [23,24]. To this end, we evaluated whether EF mediated the association between EDM use and erectile confidence. Results were not consistent with mediation in this direction. Specifically, the indirect effect of EDM use through EF was nonsignificant, as indicated by 95% CIs containing a value of zero (CI = –0.24, 0.06).

Table 3 Mediation analyses among recreational EDM users (N = 72)

Indirect effects				
	M	*SE*	LL 95% CI	UL 95% CI
Bootstrap results	–2.15	*1.36*	–5.83	–0.02
Causal step approach [20]				
	B	*SE*	*t*	sr^2
Step 1: Path *c*	–0.18	0.10	–1.97	0.05
Step 2: Path *a*	–0.26	0.13	–1.99*	0.05
Step 3: Path *b*	0.44	0.07	6.01***	0.35
Step 4: Path *c′*	–0.07	0.08	–0.87	0.006
Partial effects of covariate on erectile function				
	B	*SE*	*t*	
Age	0.93	1.55	0.60	

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$
Bootstrap sample size = 10,000. *B* = unstandardized regression coefficient. Model summary for dependent variable model: $R^2 = 0.42$, Adj $R^2 = 0.39$, $F_{3,68} = 16.28$, $P < 0.001$
CI = confidence interval; EDM = erectile dysfunction medication; LL = lower limit; UL = upper limit

Discussion

The current study examined the mediating role of erectile confidence on the association between recreational EDM use and EF among a national cross-sectional sample of young healthy men within the United States. Results were consistent with a causal mediation chain, indicating that confidence in erectile abilities indeed mediated the inverse relationship between EDM use and EF. Alternatively stated, more frequent EDM use was associated with decreased erectile confidence, which in turn showed negative relations with EF. The formal test of this indirect effect was significant, as was the traditional causal step approach [20]. These findings are in line with Santtila and colleagues [13] who reported an inverse relationship between recreational EDM use and confidence in ability to gain and hold erections among a cross-sectional sample of young Finnish men.

That recreational users, contrary to prescribed users, displayed physiological EF scores comparable to nonusers suggests that recreational users were likely not using an EDM to ameliorate clinically significant erectile difficulties. In fact, recreational EDM users showed healthy erectile functioning profiles and were well above the cutoff typically used to distinguish those experiencing ED of a clinical nature (i.e., IIEF EF score ≤ 25; [25]).

Interestingly, despite reporting high EF, recreational EDM users' levels of erectile *confidence* were disproportionately low (Table 2). Furthermore, similar to results of Santtila and associates [13], recreational users' erectile confidence levels were similar to those of prescribed users, and both groups were significantly lower than nonusers. Decreased erectile confidence has been identified as an important psychogenic risk factor for ED [26]. In fact, the IIEF [16] item that assesses this construct (item 15) shows the second highest weight in discriminating between men with and without ED [26]. To this end, it is possible that men who use EDMs for recreational purposes are at increased risk of becoming psychologically dependent, in part due to their lack of confidence in achieving and maintaining erections that are not pharmacologically induced. Recreational EDM-induced sexual performance anxiety could therefore develop and may explain why, in the present study, recreational users reported the lowest levels of overall sexual satisfaction. However, given the cross-sectional nature of the data, it is not possible to ascertain causation in this hypothesis.

An alternative interpretation of these data may be that frequent recreational EDM use among men with otherwise normal erectile abilities may lead to these men experiencing "ideal" erections that are slightly firmer and longer lasting with the aid of EDMs. This may generate unreasonable standards and expectations with respect to erectile performance, which, in turn, may lead men to misperceive their unaided erections as subpar, due to their unnatural new benchmark. In other words, it may not be that their erectile abilities after the onset of using EDMs are any worse per se, but rather their "criteria" have changed regarding normal EF, which leads to these men interpreting their EF unsatisfactorily.

Strengths of the present study include the following: (i) the recruitment of a large and diverse sample of college-aged men; (ii) the use of an anonymous web-based survey to decrease underreporting by buffering against social desirability bias; and (iii) the use of rigorous statistical methods employing both traditional and state-of-the-art approaches to mediation. A number of limitations also warrant mention. First, we acknowledge the need to exercise caution in making direct casual inferences, given the cross-sectional study design. The association between recreational EDM use and increased risk of psychogenic ED through reduced erectile confidence warrants further investigation in the form of longitudinal studies to establish temporality of a potential causal link between these variables. Second, the sample of undergraduate men may not generalize to the population of young men in the United States with respect to levels of socioeconomic status [27], as well as racial/ethnic and sexual orientation distributions (e.g., African-American individuals were undersampled while Asian Americans were overrepresented; gay men were relatively oversampled [28]). Furthermore, a portion of the study sample consisted of undergraduate students that received course credit for their participation, which may have induced demand characteristics. A third limitation concerns the use of the IIEF to evaluate EF. This instrument was originally validated among older men with the intention of assessing ED [16], and therefore its psychometric properties may not directly translate to college-aged men [29]. However, given that this measure serves as a "gold standard" self-report tool to assess male sexual function, combined with the fact that its use in research studies among younger populations is not infrequent, we believed that it would serve as the

best proxy for EF in this population. A final and important limitation concerns the pharmacological validity of EDM use itself. That is, it is impossible to discount the possibility that some EDMs were inert (pharmacologically inactive), particularly those acquired from online pharmacies.

Results of the present study have important clinical implications. The findings suggest that men who use EDMs for recreational reasons (ostensibly to acquire firmer and longer-lasting erections) may begin to loose confidence in their abilities to achieve and hold their erections without the aid of these medications, which in turn could lead to psychogenic-based ED symptoms. In addition, recreational use of EDMs may generate unreasonable standards and expectations regarding erectile performance, which could lead to men being increasingly unsatisfied with their EF. Of note, these results hold for healthy young men, the mean age of which is well below the range at which ED symptoms become more frequent. This is an important finding considering that younger men (aged 18–45 years) are responsible for the largest increase in sildenafil use among U.S. adults, representing an increase in use of 312% from 1998 to 2002 [30]. Therefore, it may be particularly important for health-care providers to educate patients on the potential for psychological dependence of EDMs, especially among relatively younger patients. Additionally, future research would benefit from exploring the relationships between recreational EDM use, erectile confidence, and EF with large enough sample sizes to explore the possible moderating role of sexual orientation. That is, given that recreational EDM use is relatively more prevalent among gay men compared with straight men [14], it is possible that the indirect effect of EDM use through erectile confidence is stronger in this subgroup.

Conclusions

In conclusion, this is the first study to examine the mediating role of erectile confidence on the relation between recreational EDM use and EF among young healthy men. Results indicated that more frequent EDM use was associated with decreased erectile confidence, which in turn showed negative relations with EF. Results underscore the possibility that recreational EDM use among men without a medical indication may have deleterious effects on sexual performance, namely, by engendering psychological dependence of these medications. Further research in the form of longitudinal studies is necessary to establish a causal link between these variables.

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Statement of Authorship

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