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Alcohol, Appetite and Loss of Restraint

Samantha J. Caton · Laurence J. Nolan · Marion M. Hetherington

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Abstract Alcoholic beverages have long been associated with feasts, celebration and marking special events. Today, it is commonplace to consume alcoholic beverages before, with and/or after a meal. Alcohol provides additional pleasure to the meal and enhances appetite. However, consuming an alcoholic beverage with or before a meal is associated with poor short-term energy compensation; energy from alcohol is additive to total energy intake with the added property of stimulating further eating. Limiting alcohol intake is an obvious means to reduce total energy intake for those who wish to lose weight. However, dieters and restrained eaters drink more and report greater binge drinking than unrestrained eaters despite employing cognitive strategies to reduce their intake. Increased intake may be attributable to greater attentional bias to alcohol related cues as well as to food cues, since these are more salient to those limiting intake. Alcohol increases energy intake in dieters, in part due to abandonment of restraint (disinhibition) and consumption of forbidden items including alcohol exacerbates attempts to resist temptation. Paradoxically, links between binge drinking or increased drinking frequency to overweight and obesity may be mediated by dietary restraint. Efforts to limit food and alcohol intake for weight control appear to be unsuccessful and have the net effect of promoting overconsumption. The potential role of restrained eating in the association between alcohol, appetite and obesity has been overlooked by much of the current research and further investigation of this is therefore warranted.

Keywords Alcohol · Appetite · Cognitive restraint · Restrained eating · Disinhibition · Obesity

> "*The love of wine is a good man's failing*…" Aristophanes 422 BC

Introduction

In Ancient Greece, wine was served at the symposium (drinking party) to celebrate various social achievements or to mark special events in the lives of young, wealthy men. The party was not complete without many toasts to various deities and a spread of opulent foods. However, the limit of 3 kraters (or jugs) of wine (mixed with water) was rarely observed perhaps inspiring the quotation from Aristophanes above. The plays by Aristophanes depicting the symposium (see for example [1]) provide an insight into the intense pleasure taken by educated and civilized society in combining food and drink as celebration and social custom. Alcohol was considered to have medicinal properties by the Romans who used wine to cure many ills. However, in modern times, whilst drinking alcohol is still considered a pleasure government agencies issue recommendations for limiting consumption for health reasons. The concern of governments is in stark contrast to the associations elicited by semantic differential techniques in consumers, who link wine with "pleasure" and beer and spirits with "social", "euphoric" and "appealing"[2]. Thus, in line with recent exhortations to limit sugar, fat and salt, the public are also encouraged to be "drink aware" (www.drinkaware.co.uk/) and to drink in moderation. There is little doubt that

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S. J. Caton (✉)
School of Health and Related Research, University of Sheffield, S1 4DA Sheffield, UK
e-mail: s.caton@sheffield.ac.uk

L. J. Nolan
Department of Psychology, Wagner College, Staten Island, NY 10301, USA

M. M. Hetherington
Institute of Psychological Sciences, University of Leeds, LS2 9JT Leeds, UK

trends indicate a rise in alcohol consumption in the USA and other western nations (see [3]), and this is happening at a time of increased prevalence of overweight and obesity. It is therefore reasonable to ask whether weight gain is linked to increased alcohol intake, or whether consumption trends for alcohol and food are simply operating in parallel with a more sedentary, mechanized lifestyle. Elsewhere in this section of the journal, the potential causal link between alcohol and obesity is considered [4]. In the present review, we shall consider the psychological role of alcohol in disrupting attempts to restrict food intake for body weight management and to consider whether the disinhibiting effects of alcohol contribute to the stimulation of overeating in dieters. We will also consider the effects of drinking restraint on overall energy intake and the role of ambivalence in creating conditions for restriction to fail.

Why Dieters Might Limit Alcohol Intake

Alcohol has several unique properties; in addition to the mood enhancing effects which are well established and understood, alcohol is high in energy density providing 7.1 kcal per gram. Energy intake from alcoholic beverages is additive to total energy intake and is poorly compensated. Thus, a robust and consistent finding in laboratory based studies is that energy given in the form of an alcoholic beverage fails to produce subsequent compensation [5–18].

In fact, alcohol appears to stimulate appetite prior to food consumption compared to no alcohol [19–22]. For these reasons alcohol consumption might be considered a risk factor for the development of overweight and obesity (see [4]). It may therefore, present a "forbidden fruit" to those who wish to lose weight. Restriction of alcoholic beverages is recommended by diet plans given its energy density and potential to stimulate appetite through the "apéritif" effect on intake. Furthermore, alcohol may act as a conditioned stimulus for eating in those who have associated alcoholic beverages with the start of a meal, or with meal onset. Thus avoiding alcohol could be a successful strategy in weight management.

Individuals who are either restricting their energy intake to prevent body weight gain (dietary restraint) or currently dieting to lose weight (dieters) may avoid alcohol, limit drinking or plan to adjust energy intake in response to alcohol energy for weight management. These adjustments might be based on the knowledge of the energy content of alcohol or by prior experience that alcohol enhances appetite and promotes excessive energy intake (expectancy effects).

Restraint theory suggests that rather than relying on internal cues that indicate satiety, restrained individuals use cognitive strategies to control their food intake. These are based on self-formulated rules regarding appropriate types and portion sizes of foods to consume [23]. Thus, limiting, avoiding or planning for alcohol intake could form part of a cognitive strategy to reduce the energy from alcohol as well as reducing the stimulatory effects of alcohol on appetite.

Dieting, Restraint and Alcohol Consumption

Dietary restraint status is typically based on self-report measures. A number of questionnaires have been developed to assess the degree to which an individual consciously limits their food intake. Such scales include the Restraint Scale (RS) [24], and restraint sub-scales from the Three Factor Eating Questionnaire (TFEQ) [25] and the Dutch Eating Behavior Questionnaire (DEBQ) [26]. Dieting status on the other hand is assessed by asking participants if they are currently dieting to lose weight or to maintain their current body weight.

Interestingly, dieting to lose weight has been associated with elevated alcohol consumption. In a large sample of adolescents (aged 13-18 yr), those who reported that they were on a diet, who scored high on food preoccupation and experienced binge eating episodes also reported a higher intake of alcohol and greater frequency of intoxication [27]. In another large sample of male and female students (aged 12 to 20 yr), those who reported the highest incidence of dieting (especially among female students who purge and only in male students who purge) also reported higher frequency of alcohol use [28]. In this study around 22 % of current dieters reported daily/weekly alcohol consumption compared to only 13 % of those who never dieted. Among adult women, those who engaged in more severe forms of dieting also reported binge drinking and more frequent drinking [29, 30] as well as more negative alcohol-related consequences [30].

One report demonstrated that alcohol consumption was higher amongst dieters compared to non-dieters. In this study dieting severity was associated with increased frequency and intensity of alcohol intake [29], although a later study by this same group failed to replicate this observation [30]. Studies where dietary restraint was measured show similar patterns of results, regardless of the scale used to record restrained eating. Among female adolescents studied for over 3 years, frequent dieters reported the largest increase in alcohol use and the highest concomitant increase in restraint (RS) over the study period [31]. Women with high restraint (RS) did not drink more often than unrestrained eaters but when they did consume alcohol they drank a larger amount [32]. Dietary restraint (TFEQ) was associated with a higher alcohol consumption reported by obese women when compared to non-obese women [33]. Restrained eating may be associated with problems in inhibitory control in general which would account both for overeating and excessive drinking. It is not known whether dietary restraint emerges in response to overconsumption or if it promotes overconsumption.

The relationship between restraint and alcohol may be mediated by other factors. For example, the association between eating disorders, alcohol and tobacco use revealed a weak correlation between alcohol use and measures of disorder (e.g. binge eating) in women [34]. However, principal components analysis demonstrated that alcohol use loaded onto a different factor than did restraint, binge eating, disordered eating attitudes, and BMI [34]. In women at risk for eating disorders, restraint (Eating Disorders Examination Questionnaire, EDE-Q) was associated with elevated binge drinking at baseline and 12 m follow up. However, binge drinking at 12 m was most strongly predicted by baseline binge drinking and restraint was no longer a predictor when this was controlled for [35]. In a study of women considered "at risk" drinkers (moderate – heavy, > 7 drinks per week), conducted across the menstrual cycle, restrained eating (TFEQ) was associated with more negative consequences from alcohol consumption (e.g. higher scores relating to problems with family/spousal relationships, trouble at work, and legal problems) and with lower alcohol consumption (fewer drinks, lower frequency of drinking and binge drinking) in the follicular phase [36•]. This study suggests that the alcohol-appetite axis is influenced by menstrual phase and may be an important consideration for research in this area.

Finally, a number of studies suggest that restrained eaters are more sensitive to alcohol-associated cues compared to unrestrained eaters. Male and female students with high restraint (RS) had longer latencies to food and alcohol cues in a Stroop test than to control cues [37]. This latency was not present in those with average and low restraint scores and was unaffected by mild food deprivation [37]. Similarly, women scoring high on restraint (DEBQ) and disinhibition exhibited attentional bias to alcohol-related words in a visual dot-probe task but only disinhibition predicted binge drinking behaviour [38]. These results suggest that those participants who score high on both restraint and disinhibition have a great cognitive preoccupation with alcohol compared to other dietary groups. Elevated attentional bias towards alcohol using methods such as the Stroop and visual probe task has been associated with elevated subjective craving in social drinkers and alcohol abusers and relapse in alcohol abusers (see [39] for review).

Alcohol and Short-term Energy Compensation

An example of successful short-term energy compensation is when individuals reduce their energy intake either in response to consuming energy in the form of a preload or in anticipation of consuming an energy dense food (planned compensation). Energy compensation may be under conscious, effortful control in the case of dieters and restrained eaters, or it might be a biological response to energy intake. Energy compensation in response to alcohol ingestion in the laboratory is typically assessed using the classic preload design; participants are offered an alcoholic beverage and an equivalent non-alcohol control preload on a separate occasion followed by an ad libitum test meal. Alcohol might promote short-term passive overconsumption [40] due to the energy from alcohol being additive to total daily energy intake [9, 12–18]. The results of these studies fail to show any compensation in subsequent energy intake to account for the energy consumed in the alcohol preload. Therefore the energy consumed from alcohol is additive to total daily energy intake, at least in the short-term. Moreover several laboratory based investigations have demonstrated that participants consumed more energy from food following alcohol relative to a no-alcohol preload [5–8, 10, 11, 19, 20]. It would be reasonable to surmise that alcohol has increased appetite either through stimulatory mechanisms or has failed to produce a sufficiently strong satiety signal, thereby producing no overall compensation. Several laboratory based studies have demonstrated that alcohol increased ratings of hunger once eating was underway [19–21] or when the dose of alcohol was sufficiently high [22]. Not all investigations have assessed the direct effect of alcohol on appetite using standard ratings and those failing to replicate this effect may be using low doses of alcohol [40]. Overall, alcohol is most often associated with elevated energy consumption (as added total energy or via increased food consumption) although the underlying mechanism is not yet clear.

Planned Compensation Prior to Drinking

Restrained eaters may overeat in anticipation of a meal low in energy content [41] or prior to going on a diet [42] and so there is evidence of planned compensation when restrained eaters expect to under consume. Recently, there has been an examination of the effect of anticipated or planned consumption of alcohol on food intake. Luce et al. (2013) [43•] reported that while restrained women (RS) ate less overall energy (but not fewer eating episodes) per day, restrained and unrestrained women were equivalent in number of drinking days, number of alcoholic beverages consumed and alcohol-related energy intake per drinking episode when there was no intention to drink alcohol. However, when intending to drink alcohol, the restrained eaters had fewer eating episodes (they also reported skipping meals in a follow-up questionnaire) compared to controls. This change in eating behaviour did not translate into less energy being consumed by the restrained group. Both groups consumed similar amounts of energy when alcohol consumption was planned thus providing no evidence of energy adjustment prior to consuming alcohol [43•]. Furthermore, restrained women who planned to drink overestimated their intoxication with the discrepancy being higher among those who reported eating more food in preparation for

drinking [44•]. This misjudgment may be due to restrained eaters having low interoceptive awareness, especially with regard to subjective sensations associated with hunger and satiety. Alternatively because restrained eaters are more aware of external cues (especially portion sizes, types, composition and amounts of food and drinks consumed) than internal cues restrained eaters might focus more on perceived consumption rather than actual intake. Thus expectancy might explain the increase in perceived levels of intoxication [44•].

Putative Explanations for the Generally Positive Relationship between Dieting and Dietary Restraint and Alcohol Consumption

Restrained eating is a cognitive strategy employed to limit intake of energy dense foods and beverages, more specifically it refers to an individual's ability to resist urges to consume what they perceive to be forbidden foods in order to prevent body weight gain. However, dietary restraint is not a static phenomenon; it varies depending on situational effects and upon the ability to control energy intake under differing conditions of temptation. Factors that reduce the ability to maintain rigid cognitive restraint are referred to as "disinhibitors" (e.g. negative emotional states, high energy dense foods, presence of others also eating and alcohol). Disinhibition can result in the abandonment of restrained eating intentions and control over intake is lost temporarily.

In a series of studies, Polivy and Herman concluded that alcohol prior to food consumption "disinhibits" eating when restrained women are aware of alcohol presence. So the belief that one has consumed alcohol is sufficient to promote over eating. Alcohol-related expectancies appear to explain "disinhibition" better than the pharmacological effects in a number of domains including aggression, sexual behaviour, and eating [45]. When unaware of the presence of alcohol in a drink, an alcohol preload suppressed eating in female restrained eaters (RS), yet eating was higher in unrestrained eaters [46]. The study was repeated and the participants were informed of the presence of alcohol. The initial findings were replicated; surreptitious alcohol consumption decreased food consumption in female restrained eaters (RS). However, an increase in consumption of ice cream by restrained eaters was found when alcohol presence was not hidden [5]. Furthermore, for unrestrained eaters, consumption varied with mood (more dysphoric mood associated with less eating); for restrained eaters it was the reverse [5]. Thus, it was concluded that the disinhibition effects of alcohol depend on awareness of alcohol expectation, not the alcohol content per se [5]. Prior to these alcohol studies, Polivy (1976) [47] reported that once restrained eaters had believed that they had already overeaten they would over consume even more. Similarly, Hibscher (1977) [48] also reported that the best predictor of over eating was dietary restraint in response to a forced preload. It seems that the relationship between alcohol consumption and dietary restraint is mediated by the "what the hell effect". Thus when a restrained eater expects to consume alcohol and actually does so, their cognitive control of food intake is abandoned and restraint is disinhibited according to the perceived energy in the alcohol consumed, this in turn leads to further alcohol and/or, food intake.

In addition to the expectancy effects, alcohol may act as a potent disinhibitor of dietary restraint [49]. However, attempts to verify this have been unsuccessful. There have been several attempts at replication of the alcohol effects found by Polivy and her colleagues. Poppitt et al. [16] asked women to come to the laboratory for four sessions; for each they drank a preload drink of varying energy content (only one of which contained alcohol) and consumed a test meal dinner. There was no difference in energy consumption between restrained (DEBQ) and unrestrained eaters despite the fact that two of the drinks (alcohol and no alcohol preloads) had alcohol related cues present in the form of gin flavour. Yeomans et al. [19] assigned men to consume a pasta test meal after one of three drinks: water, non-alcoholic drink, alcoholic (hidden) drink. Those scoring high on restraint (TFEQ) ate the same in all three conditions and those low in restraint ate less after the no-alcohol drink and more after alcohol [10, 11, 19, 22]. Similar results were reported by Yeomans [21]. Women were grouped by high and low restraint score (TFEQ) and given preloads with/without alcohol followed by buffet test meal. Alcohol increased energy consumption whether in beer (alcohol cues) or sparkling juice (no alcohol cue) but there was no effect of restraint, although intake was higher in the alcohol-sparkling juice condition [21]. Thus, none of these studies replicated Polivy and Herman (1976) [46].

Two studies have examined the interaction between restraint and alcohol when the participant was informed of the presence of alcohol in an attempt to replicate Polivy and Herman [5]. In neither study was alcohol-induced disinhibition of restraint observed. Women given an alcohol preload did not consume more crackers compared to controls and there was no disinhibition of restraint by alcohol associated with any of the restraint measures (TFEQ/RS/DEBQ) used [15]. Similarly, high dietary restraint (TFEQ) was associated with low consumption of chocolate candies compared to a control condition but restrained eaters did not eat more than controls under the influence of alcohol [50].

Alcohol and Drinking Restraint

Unfortunately few studies of dietary restraint and alcohol consumption have also examined the role of drinking restraint which describes individuals who are cognitively and behaviourally preoccupied with attempts to control their

own alcohol consumption but occasionally fail and engage in excessive drinking [51]. The restrained drinking scale (RDS) was initially adapted from the RS by Southwick and Steele (1987) [52] who reported that there was no correlation between RS and the RDS. They also reported that restrainers of alcohol were more impulsive with lower generalized self-control [52]. However, subsequent research utilizing the Temptation and Restraint Inventory (TRI) [51], a revised drinking restraint scale, has suggested that a relationship does exist. The TRI has two subscales: cognitive and emotional preoccupation (CEP) which is associated with unsuccessful regulation of alcohol consumption and cognitive and behavioural control (CBC), which is associated with concern about drinking and restriction and successful regulation of alcohol consumption (when CEP is low) in social drinkers [51]. The RS (concern for dieting, but not weight fluctuations subscale) correlated with CBC and CEP components of the TRI in women [53]. While the CEP and CBC were not correlated with TFEQ-R total, they both were positively correlated with the "emotional/cognitive concern for dieting" component (but not the "calorie knowledge" or "behavioural dieting control" components) of the TFEQ-R [53]. Furthermore, higher scores on problem drinking were associated with bulimic behaviour; those adolescents scoring high on both problem drinking and bulimic behaviour were more likely to have higher CEP on eating and drinking, higher control attempts, and low self-control [54]. Finally, women who are high in restraint (DEBQ) and disinhibition scored highest on the CEP scale of the TRI [38]. Thus, emotional preoccupation may play a role in the observed bias to alcohol-related words [38]. Drinking restraint may be another important factor to consider when examining the relationship between dietary restraint and alcohol consumption.

Conclusions

From the reviewed evidence it is clear that alcohol is associated with increased short-term energy intake (poor short-term compensation), furthermore, alcohol ingestion stimulates food intake relative to no alcohol. Individual differences, more specifically dietary restraint, influence how much alcohol is consumed, and patterns of alcohol and energy intake. Dieters and restrained eaters report increased alcohol intake and increased frequency of binge drinking despite employing cognitive strategies to reduce their intake. Restrained eaters might binge drink more due to increased attention to alcohol related cues which are, alongside food cues, more salient to restrained eaters. Furthermore, it is also possible that when under the influence of alcohol, in the presence of tempting food (or food cues) there is a shift from cognitive control (known to be a finite resource) to a more automatic response to food [55]. Furthermore, increased attentional bias towards alcohol related cues might be an indicator of increased reward sensitivity from alcohol or alternatively restrained eaters might consume more alcohol due to reduced reward sensitivity; however, this remains to be investigated. Once alcohol has been consumed, restrained eaters might abandon restraint. Once an individual "falls off the wagon" by consuming forbidden foods (a high energy content alcoholic beverage), rather than "climbing

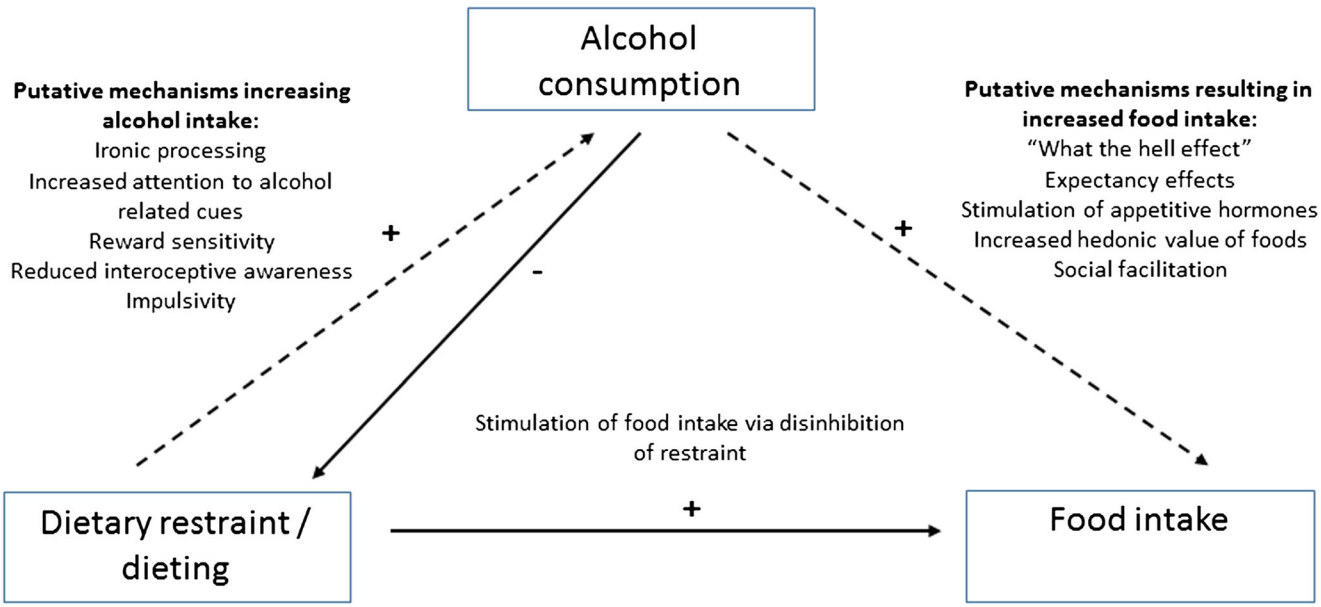

Fig. 1 **Solid arrows** represent Polivy & Herman (1976) disinhibition of restraint predictions following alcohol intake. **Dashed arrows** offer alternative explanations on how dietary restraint, alcohol intake and food intake might interact. + denotes a positive/stimulatory effect; - denotes a negative/inhibitory effect

back on" a restrained eater or dieter might see their good intentions for the day or week dashed and then the individual makes the intention to resume restraint/their diet at a later date. In keeping with the findings of early research by Polivy (1976) [47] and Hibscher (1977) [48], consumption of alcohol (a known energy dense beverage), might simply disinhibit intake resulting in further alcohol intake, and this would explain the relationship between binge drinking/increased drinking frequency in restrained eaters (Fig. 1). It is possible that the epidemiological evidence linking binge drinking and increased drinking frequency to increased risk of overweight could be mediated by dietary restraint/ dieting (see [4]). However, to date experimental evidence has failed to replicate Polivy and Hermans [5] original findings regarding short-term compensation following alcohol. More research in this area is clearly needed. Discrepancies between findings may be due to differences in measures of restraint, the types and amounts of alcohol offered and intervals between alcohol consumption and access to food.

An alternative explanation for the link between alcohol intake, appetite and restraint is that of ironic processing [56]. This theory has been applied to the problems experienced by dieters to suppress thoughts of food. Thought suppression is counterproductive and efforts to avoid thinking about a forbidden food such as chocolate [57] or in planning what to avoid eating [58] produce rebound cognitive and behavioural effects. Dieters are preoccupied with thoughts of food when attempting to restrict intake [59]. Thus efforts to limit alcohol, to suppress thoughts of consuming alcohol or avoid alcohol cues may increase intake through ironic processing rather than disinhibition (Fig. 1). Investigations of specific drinking restraint are therefore important to complete the picture on alcohol, appetite and restraint. To paraphrase Aristophanes, "*The love of alcohol is a good dieter's failing*…," perhaps the effort required to limit both total energy intake and alcohol consumption is counterproductive to attempts to restrict intake.

The interaction between alcohol, appetite and dietary restraint is complex and further work is needed to extend our knowledge at a basic level regarding how individual differences influence how much alcohol is consumed, the frequency and pattern of alcohol consumption and how alcohol intake affects both appetite control and body weight regulation. Moreover, the interaction between alcohol, appetite and dietary restraint is further embedded in a complex interaction between behaviour (food preferences, choices, and social influences), physiology (nutritional status, body weight, pharmacology) and biology (appetite and body composition regulating hormones, genetic differences). Thus, further multidisciplinary research is needed to understand the relationship between alcohol, appetite and dietary restraint.

Compliance with Ethics Guidelines

Conflict of Interest Samantha J. Caton, Laurence J. Nolan, and Marion M. Hetherington declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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