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How Moderate Alcohol Consumption Impacts Married or Cohabiting Couples in Expressing Disagreements: An Automatic Computation Model and Analysis

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Abstract— **Alcohol consumption is common in married/cohabiting couples, and many studies have attempted to understand its effects on their behavior patterns. Traditionally, those evaluations have been done through questionnaires and self-reports. While these approaches have unique contributions, they cannot track instantaneous behavioral changes, such as when a person shows disagreement, and are subjective to personal bias. Hence, we developed a computation model to automatically and objectively quantify instantaneous non-verbal disagreement expressed by head shakings and the corresponding following behavior. We conducted a preliminary analysis based on data from a randomized controlled experiment, where married/cohabiting couples discussed conflicts in different alcohol consumption conditions. Results showed that participants demonstrated different behavioral patterns in expressing moderate and strong disagreement. In addition, alcohol influenced males' head-shaking magnitude and females' following behavior more than their partners'. The proposed method is general and can be extended to investigate other behavioral cues.**

Keywords— **Alcohol consumption, head shaking, moderate and strong disagreement, following behavior**

I. Introduction

Alcohol consumption impacts marriage in a complicated way. Moderate consumption with congruent drinking behaviors may enhance marital satisfaction and reduce the possibility of divorce for couples [1], while excessive alcohol intake is likely to trigger negative effects within relationship partners [2]. Recent statistical models account for the interdependent nature of interpersonal interaction between relationship partners, highlighting the importance of inputs from both partners in predicting the behavioral and affective outcomes of either partner [3]. Research further indicates that patterns of behavioral concordance or discordance among partners may be associated with a variety of protective and risk factors for relationship stability and satisfaction [1]. Acute alcohol use by a participant or their partner, for example, has been shown to be predictive proximally of greater hostility and aggression during dyadic interaction [4].

The main goal of this study was to understand how alcohol consumption impacted the couples' non-verbal disagreement expression during their interactions. Traditional analysis of alcohol consumption and its impact on partner behavior relied on self-reports, human observations, and offline manual coding of experiment recordings [5]. While these traditional methods can describe behavioral patterns on a scale of life events, it is difficult to use these methods to track meaningful real-time, instantaneous (e.g., on a scale of seconds) behavioral events. A typical example is checking when a person demonstrates disagreement through shaking head, which is one of the most commonly used non-verbal cues of disapproval in diverse social contexts how the partner follows this message non-verbally [6]. Indeed, temporal sequencing and following patterns of dyadic behavior have emerged as important predictors of relationship outcomes, including aggression, whereby a participant's adaptive or maladaptive behavior is elicited from not only his own initial response but also the response of his partner to his initial response [7].

Therefore, we propose a new computation model to automatically detect if a person initializes disagreement and if the partner follows the disagreement using videos of head movements. Based on an existing dataset, a preliminary analysis was conducted to show how moderate alcohol consumption impacts married/cohabiting couples in demonstrating disagreement. The following sections are organized as follows. Section II introduces the proposed new model. Section III shows the analysis results of the dataset. Section IV concludes the articles and discusses important future work.

II. Methods

A. Couple Conflict Dataset

This study applied a dataset collected by Testa et al. to understand the impact of alcohol (target dose: 0.08 mg/kg) on intimate partner interactions in conflicts [5]. 152 mixed gender intimate couples, married or cohabiting, were recruited and randomized to one of four experimental groups (G_1 to G_4). Each couple engaged in two 15-minute sessions, one (S_1) before and one (S_2) after beverage administration, where they talked about current disagreements in their relationship. Alcoholic beverages consisted of 80 proof vodka mixed with cranberry juice in a 2.39 ml/kg ratio for males and 2.22 ml/kg for females, with a target BrAG of .08%. The no-alcohol beverages were an equivalent amount of juice. In G_1 (n = 40), G_2 (n=39), and G_3 (n=37), both the male and female, only the male, and only the female consumed the alcoholic beverages, respectively. In G_4 (the control group, n=36), both had no-alcohol beverages. Videos of both S_1 and S_2 were recorded for analysis. Videos of 10 couples in each group were randomly selected for the current study.

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B. Head shaking behavior definition

As illustrated in Fig. 1 (a), head shaking is back-and-forth horizontal head rotations (e.g., yaw rotations). Yaw degrees can be detected using head pose estimation algorithms. In this study, we applied a convolutional neural–network-based method, Deepgaze [8], for its robustness and good estimation precision. Since people's natural head-shaking cycle (one back and forth motion) usually takes more than a second [9], to eliminate unnecessary computation, we down-sampled the recorded experimental videos by one frame per second and extracted a sub-image of 320 pixels × 320 pixels around participants' head within each frame for head pose estimation.

Along the temporal sequence of yaw angles (one angle/second), a peak (left-right-left turn) or valley (right-left-right turn) represent a head shake cycle. While Deepgaze can detect a small rotation of 1°, only larger peaks/valleys that correspond to head shakes can be observed with bare eyes may indicate socially meaningful disagreement. Therefore, smaller movements (usually caused by illumination flickering or slight head movements due to mouth movement when talking) need to be removed as noise. To understand what yaw degree change corresponds to the smallest human-observable socially meaningful head shaking, three independent human coders were recruited, each coded a different video randomly selected from the study database. Results of all three coders showed that the smallest head-shaking corresponded to absolute yaw angle change of about 4°/s within one head yaw cycle. Any small yaw movements below this threshold were eliminated as noise.

Since the cameras for recording the female's and male's videos were placed at arbitrary angles, the observed head shakings were around a baseline angle decided by the location and angle of the camera. The baselines were irrelevant to the participants' head shaking, and thus were corrected as 0, with all head shakings yaw angles shifted accordingly.

To understand when head shakings happened and their magnitudes, we first searched and identified the locations and magnitudes of local extremums (peaks and valleys) in the time series of head yaw angles. From the experimental videos, we found one head-shaking cycle (left-right-left or right-left-right) that tended to mean disagreement usually lasted for 2-3 seconds. Thus, on a resolution of one yaw angle/sec, a meaningful peak had 1-2 sec increasing before the maximum and 1-2 sec decreasing after the maximum, with the total duration ≤ 3 sec and the absolute speed of each side ≥ 4°/s. Similarly, a meaningful valley has 1-2 sec decreasing before the minimum and 1-2 sec increasing after the minimum. In both cases, with the total duration around the local extremums ≤ 3 sec. Fig. 1(b) demonstrates some examples.

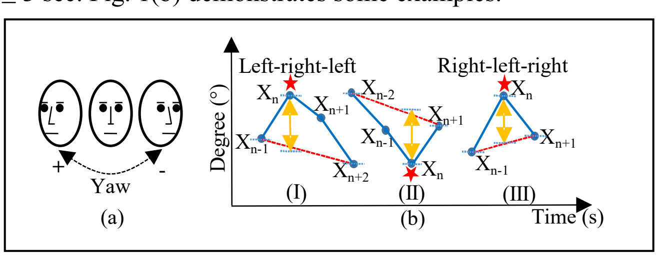


Figure 1. Demonstration of head-shaking behavior. (a). Illustration of yaw rotations. (b). Peak and valley magnitude definition and calculation. The red stars mark the locations of extremums for peaks and valleys.

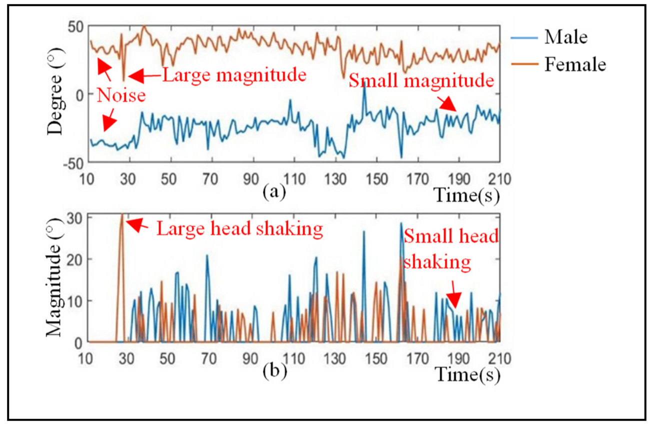


Figure 2. An example of the whole data processing. (a). Raw head yaw angle sequences of one couple in G_1. (b). Yaw angle sequences after denoising, baseline correction, and flipping valleys into peaks.

C. Following behavior analysis

During a couple's conversation, to understand who initiated disagreement and if the other also demonstrated disagreement following the first person, we designed a new Following Behavior Recognition algorithm. This algorithm outputs the numbers of two possible following behaviors, female-followed-male (FFM) and male-followed-female (MFF).

A following behavior is limited within an acceptable time range as two head-shaking cycles far away from each other were unlikely to be socially related. In other words, to qualify for a following behavior, the time difference between a pair of head-shaking cycles of male and female should be limited. This can be achieved using two parameters, D_{max}, the distance between the two maximums, and D_{con} the distance from the end of the first cycle to the beginning of the second cycle, as shown in Fig. 3 (a). Two peaks (each from one person) form a following behavior if they are matched:

$$\text{i.e., } D_{max} \leq T_1 \ \& \ D_{con} \leq T_2.$$

After consulting with a psychologist who is an expert on related topics, T_1 and T_2 were set as 5*s* and 3*s* for the experimental dataset, respectively.

A long head-shaking movement might include a few cycles. Of the same person, if the distance between the end of one peak and the start of the next peak was less than 1 second, we consider the two peaks were self-continuous. To avoid unnecessary repetitive counting of following behaviors from nearby head-shaking cycles in two self-continuous sequences, only one following will be counted from two self-continuous sequences even if there were more than one pair of peaks matched (see Fig. 3 (b)).

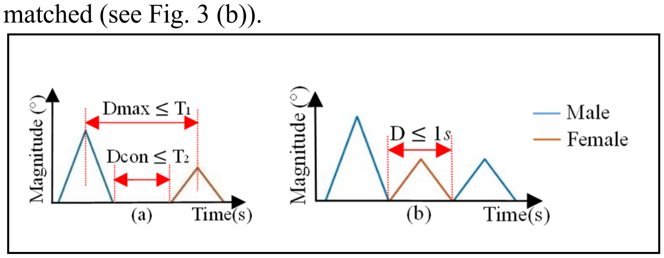


Figure 3. Following behavior definition. (a). Demonstration of time difference limitations between two cycles; (b). An example of self-continuous sequence.

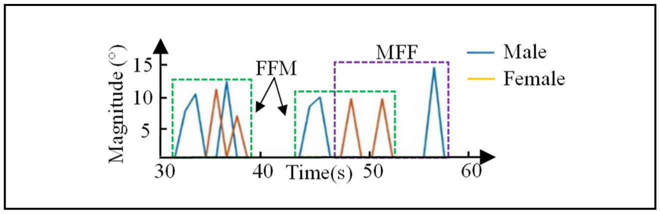


Figure 4. Illustration of following behaviors.

Algorithm 1: Following Behavior Recognition

Input: Female's and male's peak sequences, T_1, and T_2
Output: Number of FFM (N_1) and MFF (N_2)
1: Locate isolated and self-continuous subsequences for both female and male
2. Synchronize the subsequences of female and male to search for matched pairs (suppose N pairs in total)
3: Initialization: $N_1 = 0$; $N_2 = 0$
4: **for** i = 1 : N
  if male's peak appeared first, $N_1 = N_1 + 1$
  elseif female's peak appeared first, $N_2 = N_2 + 1$
5: **return** N_1, N_2

Algorithm 1 summarizes the Following Behavior Recognition algorithm. Here isolated peaks (without nearby peaks) are treated as a subsequence with only one peak, while a self-continuous subsequence has two or more peaks linked together. First, for each person in the couple, the locations of the beginning, maximums, and the end of each subsequence were extracted. Then, all subsequences from both the female and the male were aligned along the time to search for matched pairs. Finally, in each matched pair, if the female's peak appears before the male's, an MFF is counted, vice versa for FFM. Fig. 4 demonstrated examples of MFF and FFM.

III. Result of Dataset Analysis

Both within-group and across-group comparisons were conducted in the following content. According to the Lilliefors test, the data distribution was non-normal. Due to the small sample size and non-normal data distribution, nonparametric statistical analyses, the two-sided Wilcoxon signed-rank test and the two-sided Wilcoxon rank-sum test, were applied for within-group and across-group comparisons, respectively, with a significant level of $p < 0.05$. Significances with at least a medium effect size (Cohen's $d \geqslant 0.5$) were discussed. Three comparisons were conducted: 1) Within each group and each session, females and males were compared to understand how the same alcohol consumption condition impacted different sexes. 2) Within each group and each sex, S_1 and S_2 were compared to understand how alcohol consumption impacted the same individuals. 3) Across groups and within each sex, the same sessions were compared to understand how different alcohol consumption conditions impacted each sex. Considering comparisons in S_1 (before alcohol consumption) were the baseline references, we focus on changes from significance in S_1 to non-significance in S_2 and from non-significance in S_1 to significance in S_2.

A. Head shaking magnitudes

Fig. 5 (a) and (b) show the mean and standard error of small head-shaking magnitude and large head-shaking magnitude, respectively. Significant differences are marked. Fig. 5 (a) (see caption for the meaning of symbols) shows that in small head shakings, males had significantly higher magnitude in G_1 than G_2 ($p = 0.03$, $d = 0.69$) and G_4 ($p = 0.04$, $d = 0.61$) in S_1, while such significance disappeared in S_2. In other words, before alcohol consumption (S_1), although males in G_1 showed significantly higher weak disagreements than males in G_2 and G_4, after drinking alcohol (S_2), the significance was gone. This indicated males demonstrated relatively lower weak disagreements after both females and males drank alcohol. Fig. 5 (b) shows that in large head shakings, males had significantly higher magnitude in S_2 than S_1 ($p = 0.00$, $d = 1.38$) in G_1. This indicated after both partners drank alcohol, males demonstrated greater strong disagreements than they did before drinking alcohol. In addition, males had significantly higher magnitudes in G_1 ($p = 0.00$, $d = 1.13$) than G_2 in S_2, while this significance did not exist in S_1. This meant after both partners consumed alcohol, males demonstrated higher strong disagreements than they had before drinking compared to the male only alcohol condition.

In summary, only males demonstrated changes from S_1 to S_2, indicating alcohol might impact males more than females. In addition, the statistics in small and large head shakings were quite different, demonstrating the importance of analyzing these two sets separately.

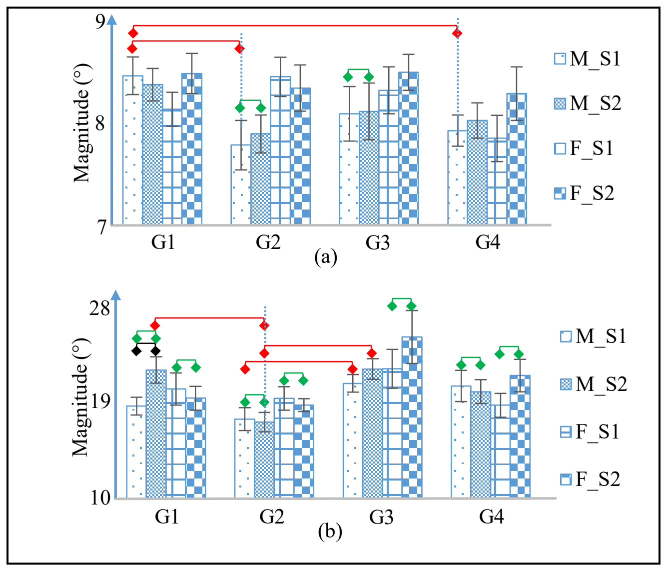
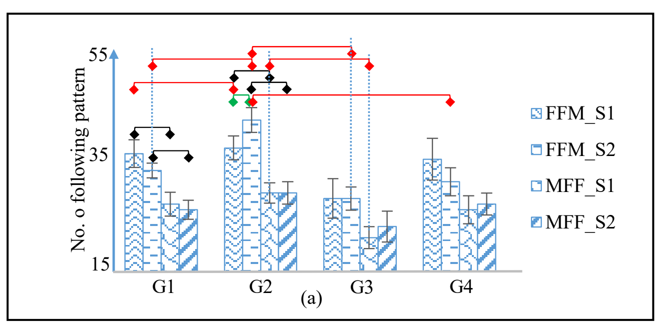


Figure 5. Mean and standard error of: (a). small head shaking magnitude; and (b). large head shaking magnitude. Black lines mark the significant differences between sessions within a group; Red lines mark the significant differences across groups within the same session; M: male; F: female; S_1: the first session without drinking alcohol; S_2: the second session where different group had different alcohol consumption conditions. G_1: both partners drank alcohol after S_1; G_2: only the male drank alcohol after S_1; G_3: only the female drank alcohol after S_1; G_4 none drank alcohol after S_1.



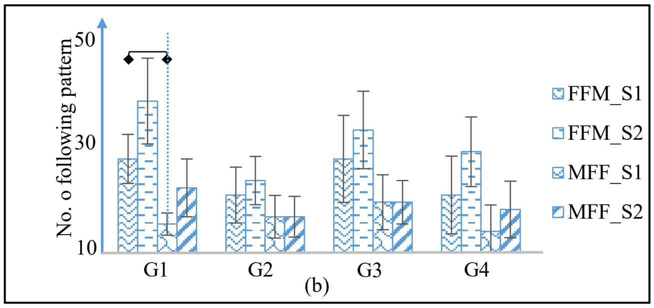


Figure 6. The average and standard error of the number of following behaviors calculated from (a). small head shaking, and (b). large head shaking. Black lines mark the significant differences within the same sessions in a group; Red lines mark the significant differences within the same sessions across groups. S_1: the first session without drinking alcohol; S_2: the second session where different group had different alcohol consumption conditions. G_1: both partners drank alcohol after S_1; G_2: only the male drank alcohol after S_1; G_3: only the female drank alcohol after S_1; G_4 none drank alcohol after S_1.

B. *Following behaviors*

Fig. 6 (a) and (b) show the mean and standard error of the number of following behaviors captured for small and large head shakings, respectively, with significant differences marked. In general, more FFMs were detected than MFFs, showing females were more likely to follow males. From Fig. 6 (a), FFM was significantly higher in G_1 than G_3 ($p = 0.03$; $d = 0.67$) in S_2, while no significance existed in S_2. Considering in S_2, both partners consumed alcohol in G_1 and only females drank alcohol in G_2, this result indicated that drinking alcohol together with males may reduce females' following behavior further, compared to the condition where only females consumed alcohol. FFM was significantly higher in G_2 than G_1 ($p = 0.00$; $d = 1.19$), G_2 ($p = 0.00$; $d = 1.79$), and G_3 ($p = 0.00$; $d = 0.97$) in S_2, while no significance existed in S_1, indicating females were likely to show the most following behaviors when only males consumed alcohol, compared to other conditions. In S_1, FFW was significantly higher in G_2 than G_3 ($p = 0.03$; $d = 1.16$), while this significance was gone in S_2. This indicated males tended to have reduced following behaviors after drinking alcohol only by themselves, compared to after only females drank alcohol. From Fig. 6 (b), the only significance detected was that between FFM and MFF in S_1 of G_1 ($p = 0.03$, $d = 1.09$), and this significance was gone in S_2, indicating differences were reduced between females' and males' following behavior after both consumed alcohol.

In summary, females demonstrated more changes from S_1 to S_2 than males, indicating alcohol may impact females more than males regarding following disagreement expressions.

IV. Conclusion

The main contribution of this work is two-fold: 1) we proposed a new computation model to automatically quantify instantaneous non-verbal disagreement expressed by head shakings and the following behaviors of such disagreement; 2) we conducted a preliminary analysis that demonstrates how alcohol may impact married/cohabiting couple in expressing disagreement using the Couple Conflict Dataset. To the best of our knowledge, this work is among the first that investigated the impact of alcohol on the communication between married/cohabiting couples regarding disagreement using behavioral patterns automatically extracted from interaction videos.

The preliminary results showed that females and males displayed different behavioral patterns in demonstrating moderate and strong disagreement. While findings regarding alcohol consumption conditions might not be conclusive due to the small sample size and limited experimental setup, analysis results demonstrated that alcohol influenced males' head shaking magnitude and females' following behavior more than their partners'. Another important limitation was that this work only focused on head shaking as it is one of the most commonly used non-verbal expressions of disagreement. However, although not used as often as head shaking, there are other non-verbal cues of disagreement, such as gestures and eye gazes, and these may change across culture [10]. In addition, it is important to validate head-shaking against self-report and other coded data to see if head shaking maps on to other indicators of disagreements.

Therefore, in the future, it is meaningful to conduct analysis on a larger sample size and combine communication cues within and across modalities, such as different sources of both non-verbal and verbal cues. Computation models/algorithms will need to be carefully designed/tuned to ensure a good balance among different cues and accommodate potentially large individual variation.

Nevertheless, this work provides an example of automatic and objective behavioral/psychological analysis, which can help expedite data analysis and avoid personal bias in the manual analysis (e.g., manual video coding). The following behavior quantification methods could be adapted to analyze other behavioral cues, such as hand gestures and gaze.

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