# Social Synchrony in Youth at Risk for Psychosis
# Results from CALMS: a Biofeedback Videogame Intervention

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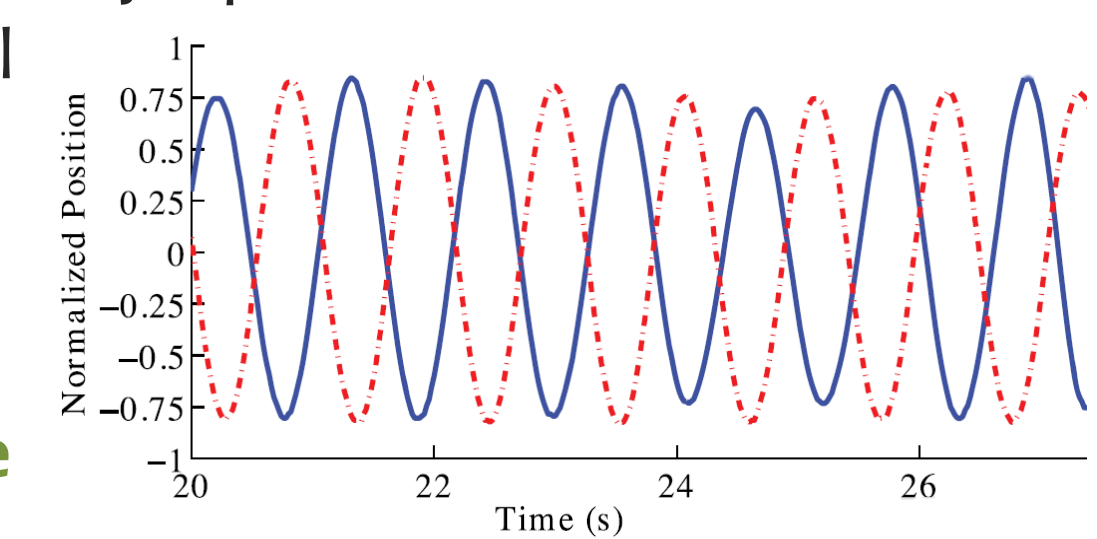Joyce Cheng,[1] Kristen Woodberry[1,3]

## BACKGROUND

Motor coordination between individuals plays an important role in successful social interactions.

**Social synchrony** is a measure of the subtle give-and-take in social interactions, seen in **rhythmic, reciprocal patterns of movement and behavior** between two people. For many people, these processes are automatic. However, **those with schizophrenia and other psychotic disorders have been found to show significant deficits in social synchrony** (Rafford et al., 2015). This is important, because nonverbal behavior is a fundamental part of communication and social connectedness. In disorders such as schizophrenia, social deficits often surface long before a person is diagnosed with the disorder (Varlet et al., 2012), making social synchrony a potential biomarker for various mental illnesses associated with diminished social functioning This also makes synchrony a prime target for investigation in a clinical high-risk (CHR) population.

An example of synchronized body positions of participants taking part in a motor coordination task (Varlet et al., 2012).

This study sought to **test whether social synchrony between CHR youth and their parents increased over the course of a therapeutic biofeedback-based video game.** In addition, synchrony data were compared to participants' self-reports of conflict in their relationship.

## METHODS

### Participants

9 parent-child dyads, with adolescents meeting criteria for CHR according to the Structured Interview of Psychosis-Risk Syndromes (Miller et al., 2003), provided pre-post synchrony data.

|  |  | Enrolled (n=11) | Pre-Post (n=9) |
|---|---|---|---|
| **Age (Mean ± SD)** |  | 17.18 ± 2.4 | 17.22 ± 2.7 |
| n (%) |  |  |  |
| **Gender** | Male | 7 (64%) | 6 (67%) |
|  | Female | 3 (27%) | 2 (22%) |
|  | Other | 1 (9%) | 1 (11%) |
| **Race** | White | 6 (54%) | 5 (56%) |
|  | Hispanic/Latino | 3 (27%) | 2 (22%) |
|  | Black | 2 (18%) | 2 (22%) |
|  | First Nations | 1 (9%) | 1 (11%) |
|  | Asian | 0 (0%) | 0 (0%) |

**Table 1.** Participant demographics

### Videogame intervention

**Computer Aided Learning for Managing Stress (CALMS)** is a 12-session family therapy. It utilizes a biofeedback video-game designed at Boston Children's Hospital to help participants reduce stress reactivity (Ducharme et al., 2012). During gameplay, both players must work together and keep their heart rates below a threshold to score points, thus targeting communication & self-regulation skills.

### Synchrony & Self-Report Data

Before and after the treatment, dyads were videotaped in a 10-minute interaction during which they were directed to problem-solve a topic that created tension between them. Synchrony was calculated using nonlinear spectral analysis of the pixel changes for both participants' movements. Correlation coefficients were then compared to a virtually-generated control condition of random synchrony. In the factor analysis of synchrony and self-report data, two pairs were removed due to exhibiting chance synchronization.

Dyads also completed the Perceived Criticism Scale (PCS) and Conflict Behavior Questionnaire (CBQ). On the PCS, each person rated how critical s/he is of the other, and how critical the other is of him/her. On the CBQ, each responded to a number of variables assessing the level of conflict in their relationship.

## RESULTS

### 1. Change in Social Synchrony during CALMS

At baseline, coherence scores in the CALMS pairs were not significantly above chance (control). **Following the videogame intervention, coherence of CALMS pairs was significantly greater than both baseline scores and the chance control** (Figure 1,2).
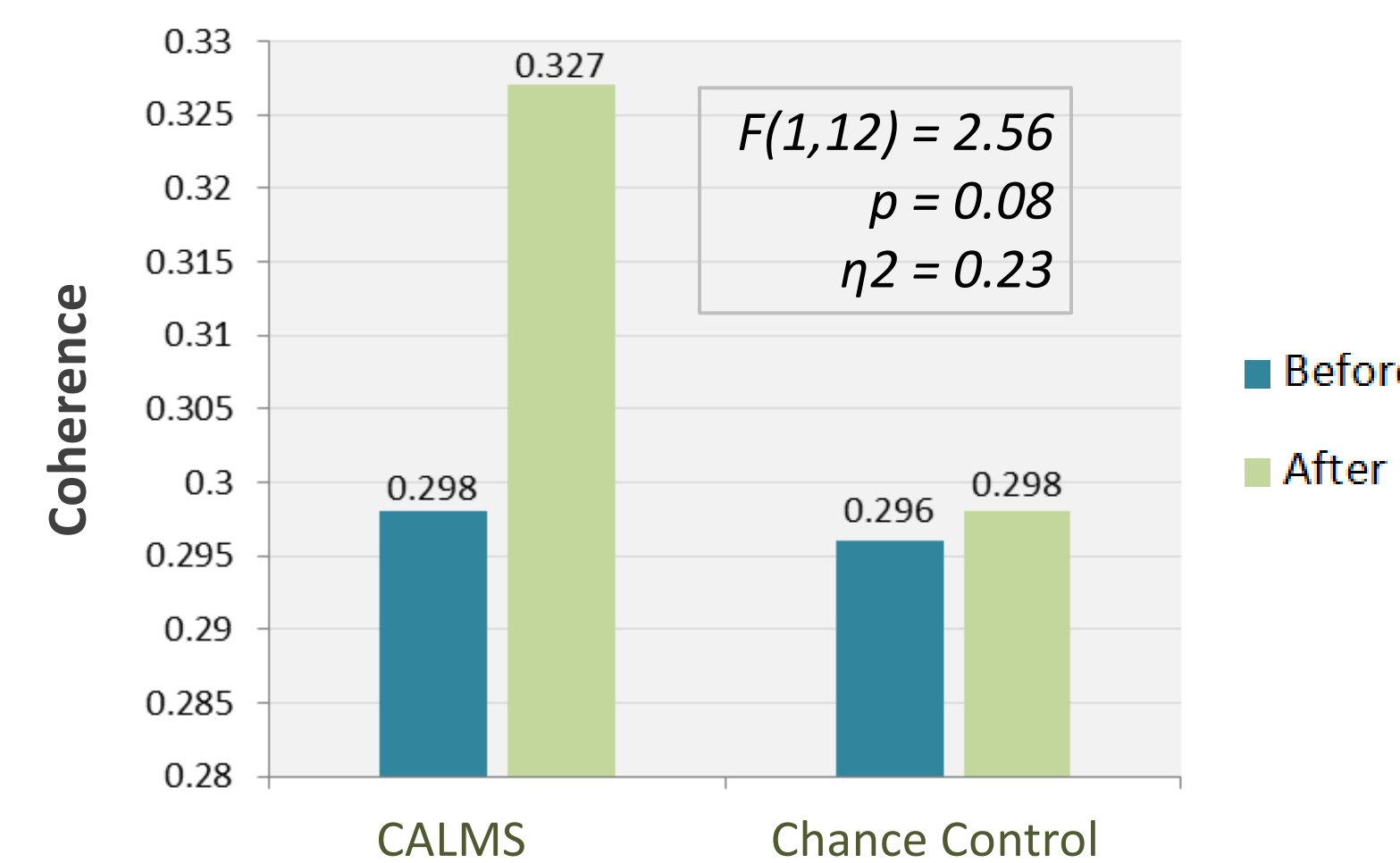


$F_{(1,12)} = 2.56$
$p = 0.08$
$\eta^2 = 0.23$

**Figure 1.** Coherence before and after videogame intervention compared to virtual control condition

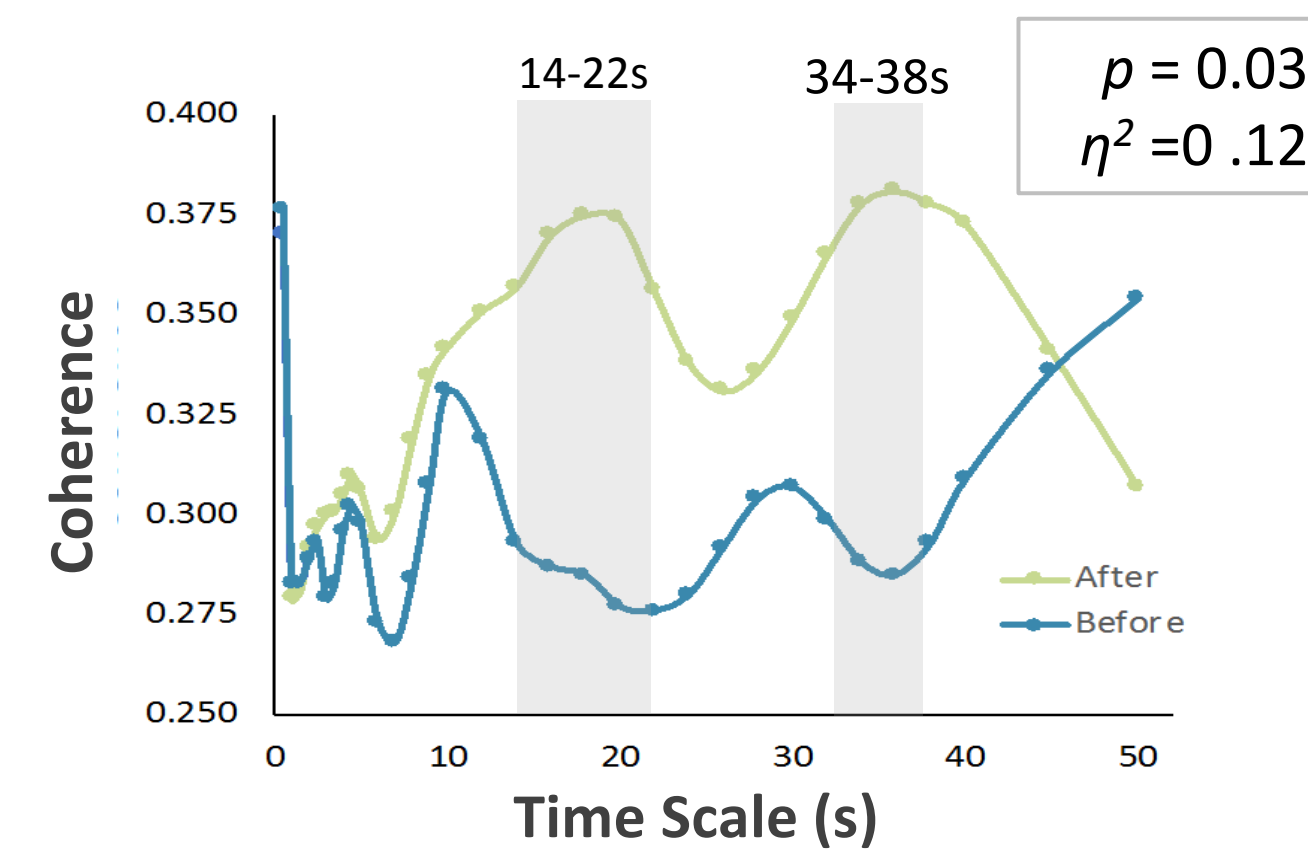

$p = 0.03$
$\eta^2 = 0.12$

**Figure 2.** Key frequencies of synchrony (significant pre-post changes shaded)

### 2. Association of Synchrony Change to Changes in Symptoms and Interpersonal Conflict & Criticism

We conducted a Principal Components Analysis using 7 pairs whose synchrony was greater than chance to examine the clustering of change across measures.

Increased synchrony at shorter frequencies was associated with decreased criticism and conflict and improved functioning, but increased symptoms (Table 2). These results support our hypothesis that **reduced conflict in the parent-child relationship will be associated with better synchrony.**

Decreased symptoms and increased functioning were also associated with increased coherence at 30 second intervals (Table 2). This suggests that **improved overall wellbeing may be related to improvements in social synchrony, such as turn-taking, at specific behavioral frequencies.**

| Change | 1 | 2 |
|---|---|---|
| SIPS Total | .445 | -.563 |
| GAF Score | .595 | .586 |
| Average Ratings of Criticism | -.885 | - |
| Average Ratings of Conflict | -.678 | - |
| Coherence (3.5 sec) | .928 | - |
| Coherence (9 sec) | .694 | - |
| Coherence (32 sec) | - | .871 |

**Table 2.** Rotated Component Matrix from factor analysis of changes in symptoms, functioning, parent-child criticism, conflict and synchrony

### 3. Lag in Interaction for Youth & Parent

Our analysis also examined the interpersonal dynamics of the parent-child interaction compared to a random control condition.

During the baseline interaction task, youth movements lagged behind their parents to a degree significantly greater than the control comparison, suggesting that **parents led the interaction prior to CALMS.**

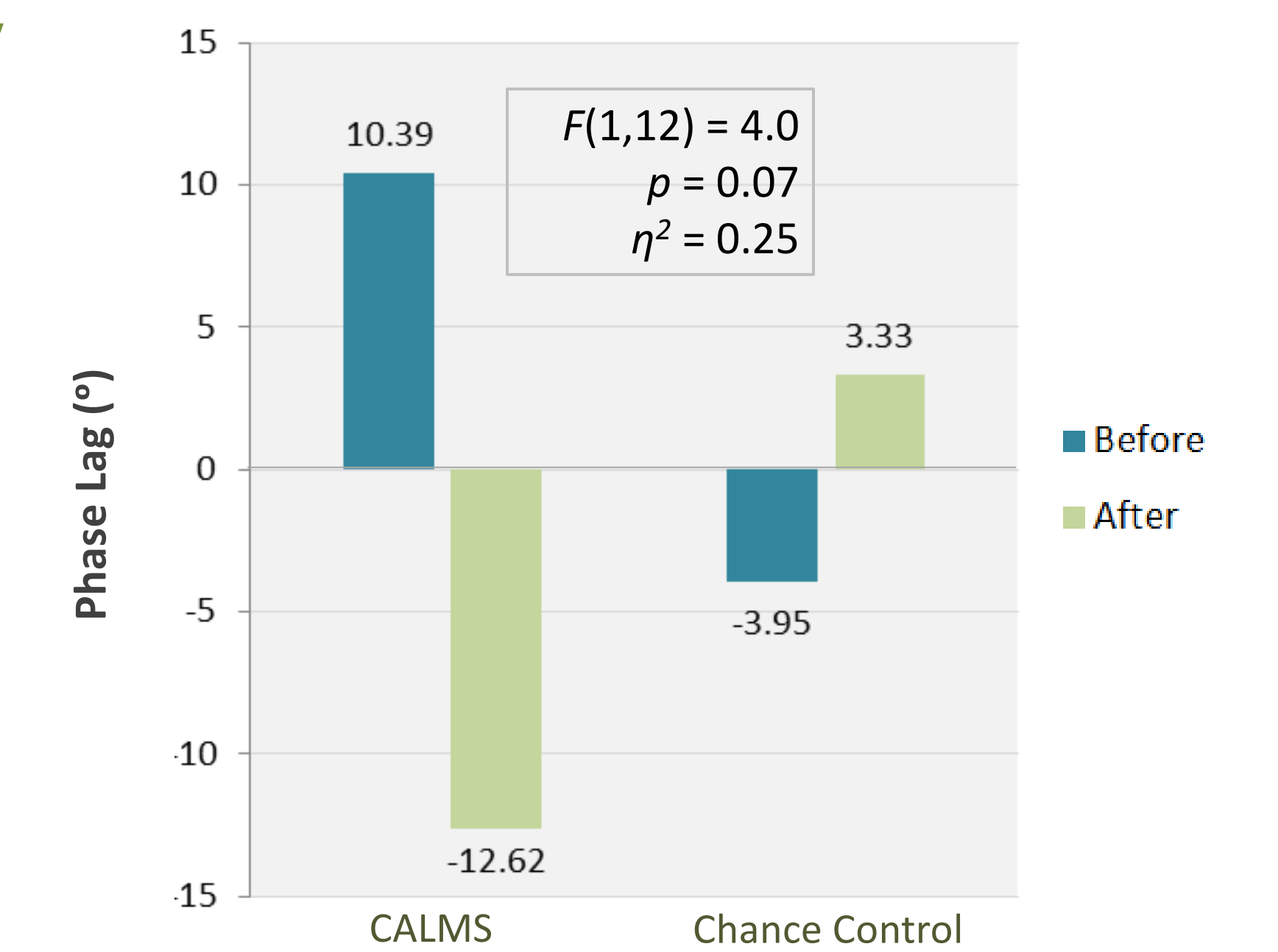Following CALMS, however, **youth led the interaction with parents following.** (Figure 3)



$F_{(1,12)} = 4.0$
$p = 0.07$
$\eta^2 = 0.25$

**Figure 3.** Lag in interaction (positive indicates parent leading, negative indicates youth leading)

## CONCLUSIONS

**Cooperative multiplayer videogames may present a fun, engaging tool to address social deficits in youth at risk for psychosis.** Dyads participating in the CALMS family therapy feasibility trial showed a significant increase in synchrony over the course of participation, which suggests that these games may foster social coordination between players in real life.

Data indicate that youth-parent interactions may be enhanced in certain rhythms of synchrony, including both short (ex. hand gesturing) and long frequencies (ex. extended talking/listening & turn-taking). Decreased conflict and criticism are most closely linked to changes at shorter frequencies, whereas improved clinical symptoms and functioning relate more closely to increased synchrony at longer frequencies (Table 2).

**Videogames may also afford a unique medium for helping youth find their voice and take initiative in their relationships with their parents**, as is evident from our data on shifting phase lag (Figure 3).

Multiplayer videogames show promise for enhancing social interaction and familial support for CHR youth and warrant further development, clinical applications, and research. Future analyses at the individual pair level are planned to examine the significance of sociomotor synchrony at specific frequencies.



Screenshot of CALMS game with biofeedback (heart rates, shown bottom center)

## REFERENCES

Raffard, S., Salesse, R. N., Marin, L., Del-Monte, J., Schmidt, R. C., Varlet, M., . . . Capdevielle, D. (2015). Social priming enhances interpersonal synchronization and feeling of connectedness towards schizophrenia patients. *Scientific Reports, 5*(1). doi:10.1038/srep08156

Varlet M, Marin L, Raffard S, Schmidt RC, Capdevielle D, et al. (2012) Impairments of Social Motor Coordination in Schizophrenia. *PLoS ONE 7*(1): e29772. doi:10.1371/journal.pone.0029772

Miller TJ, McGlashan TH, Rosen JL, et al. Prodromal assessment with the structured interview for prodromal syndromes and the scale of prodromal symptoms: predictive validity, interrater reliability, and training to reliability. *Schizophr Bull*. 2003; 29(4): 703.

Ducharme P, Wharff E, Kahn J, et al. Augmenting anger control therapy with a videogame requiring emotional control: a pilot study on an inpatient psychiatry unit. *Adolesc Psychiatry*. 2012; 2(4): 323-332.

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