Sex Differences in the Efficacy of Time-based Interventions to Promote Self-control

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INTRODUCTION

- Impulsive choice refers to choosing a smaller, sooner reward (SS) over a larger, later reward (LL).
- Impulsive individuals discount a reward's value at a much steeper rate, which is associated with ADHD and substance abuse in humans.[1,2,3,4]
- Sex differences in delay discounting are not well studied, but there are differences in related behaviors. [5]
  - Men are more likely to develop substance abuse disorder, but women progress from initiation to dependence more quickly. [5]
  - Female rats learn cues in conditioning paradigms faster than males.[6]
- Time-based interventions have been developed to moderate impulsive choices.
  - A fixed-interval (FI) intervention decreased impulsive choices in male and female rats separately.[7,8]
- This study directly compared male and female rats' impulsive choice behavior following an FI intervention.
- Hypotheses:
  - The FI intervention should promote greater LL choices compared to the control condition.
  - The intervention should increase LL choices for both male and female rats.

METHODS

- **Animals**
  - 24 male and 24 female experimentally-naïve Sprague-Dawley rats were used.
  - Three male rats were removed due to health issues.
- Male and female rats were randomly assigned into two groups; fixed-interval (FI) or no delay (ND).
  - FI Females (n=12)   ND Females (n=12)
  - FI Males (n=10)   ND Males (n=11)
- **Intervention**
  - FI: SS (1 p, 10 s); LL (2 p, 30 s)
  - ND: SS (1 p, 0 s); LL (2 p, 0 s)

  s = seconds
  p = pellet(s)

- **Impulsive Choice Task**
  - Phase 1: SS (1 p, 5 s); LL (2 p, 30 s)
  - Phase 2: SS (1 p, 10 s); LL (2 p, 30 s)
  - Phase 3: SS (1 p, 20 s); LL (2 p, 30 s)
- **Data Analysis**
  - The last five sessions of each phase of the choice task were analyzed using a multilevel mixed-effects regression model with an intercept at a zero delay.
  - Choices at the intercept provided an index of the preference for immediacy.
  - The slope of the regression function provided an index of sensitivity to delay.
  - A multilevel mixed-effects spline regression model was used to examine acquisition following the FI intervention. The entirety of each phase was treated as one session.
  - The Phase 2 slope was entered as a random effect.
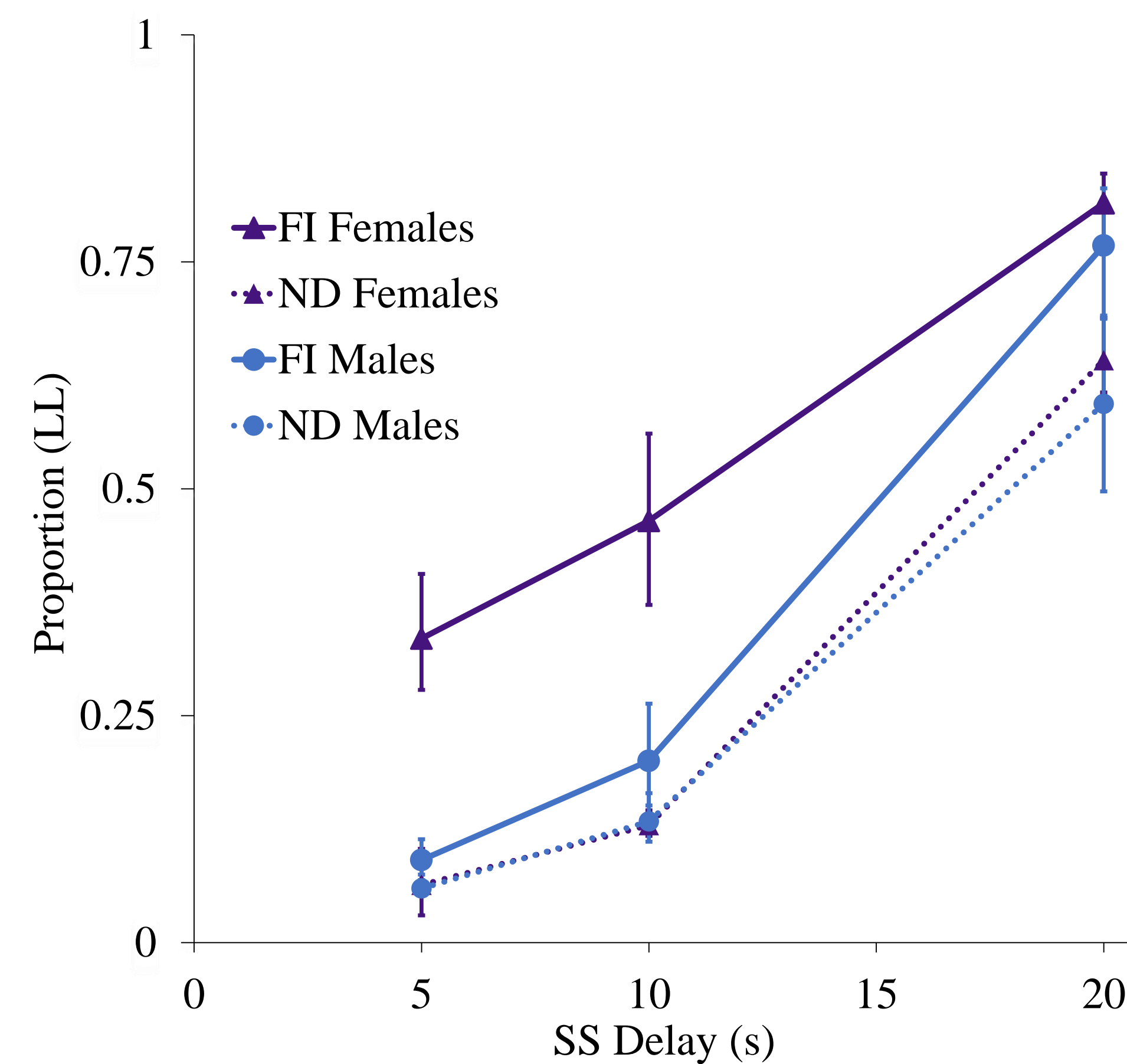
RESULTS

Figure 1. Proportion of LL choices as a function of SS delay. The FI females made more LL choices and displayed a decreased preference for immediacy. Sex differences diminished as SS delay increased suggesting both sexes preferred larger rewards. The FI females displayed decreased sensitivity to delay compared to the FI males. The ND groups did not differ between sexes.
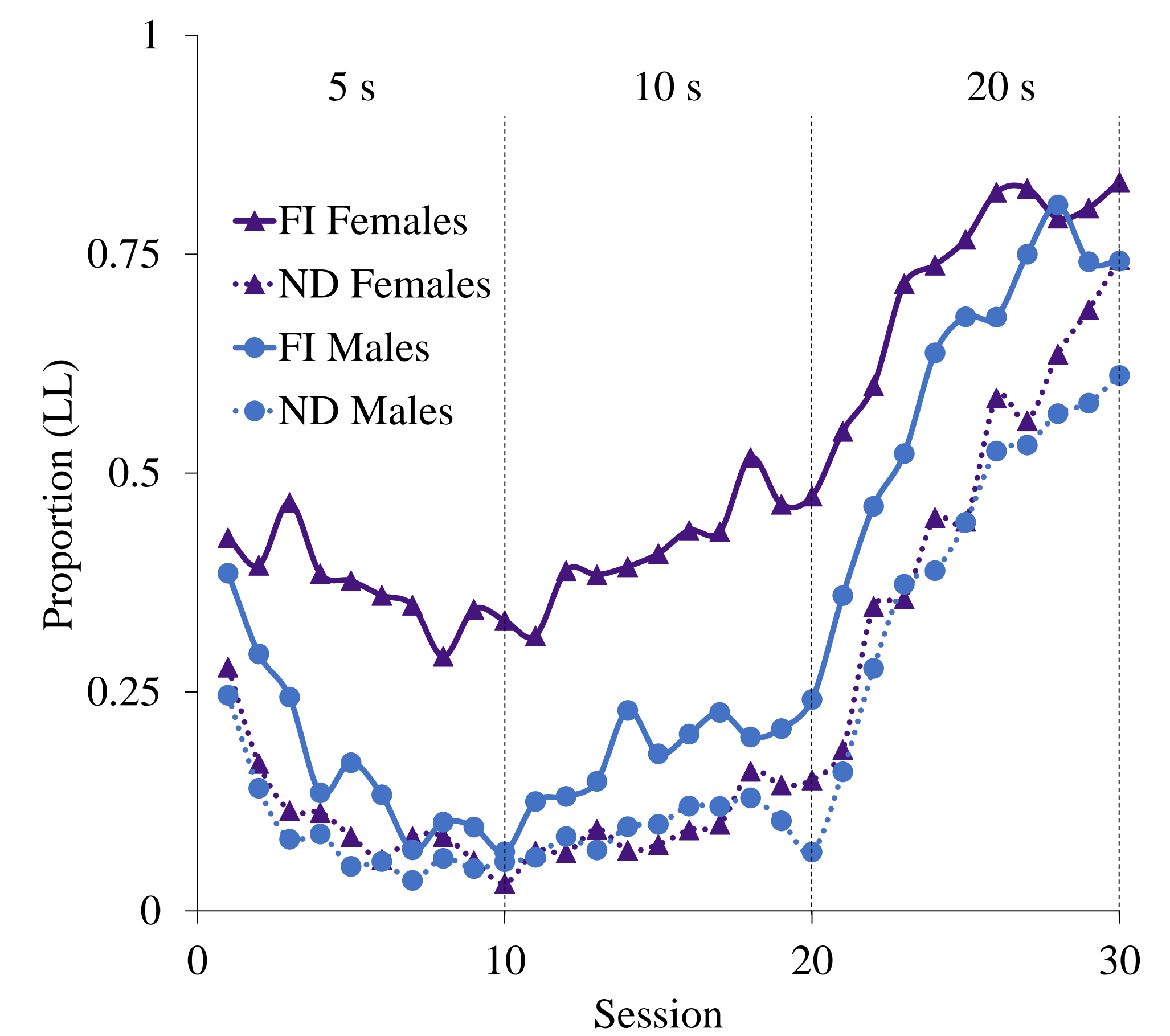

Figure 2. Proportion of LL choices as a function of session. Both FI males and females showed an initial higher preference for the LL in the first session. However, the FI females had a shallower slope over the 10 sessions suggesting decreased preference for the 5-s SS delay, whereas the FI males showed attraction to the SS.
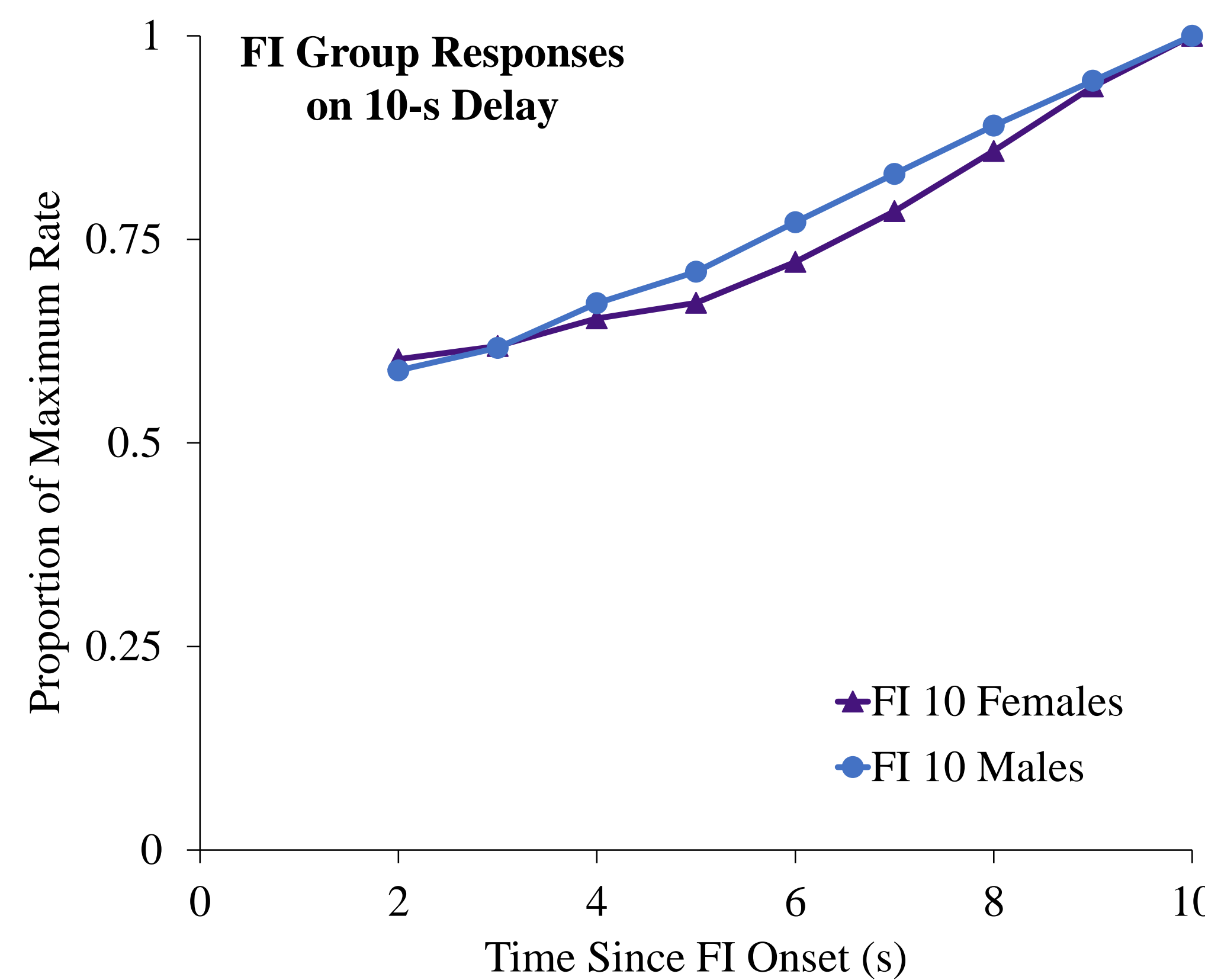

Figure 3. Response rate during 10-s fixed-interval intervention. There was no difference between sexes in the response rate functions during the 10-s FI intervention. This suggests males and females timed this delay similarly during the intervention.
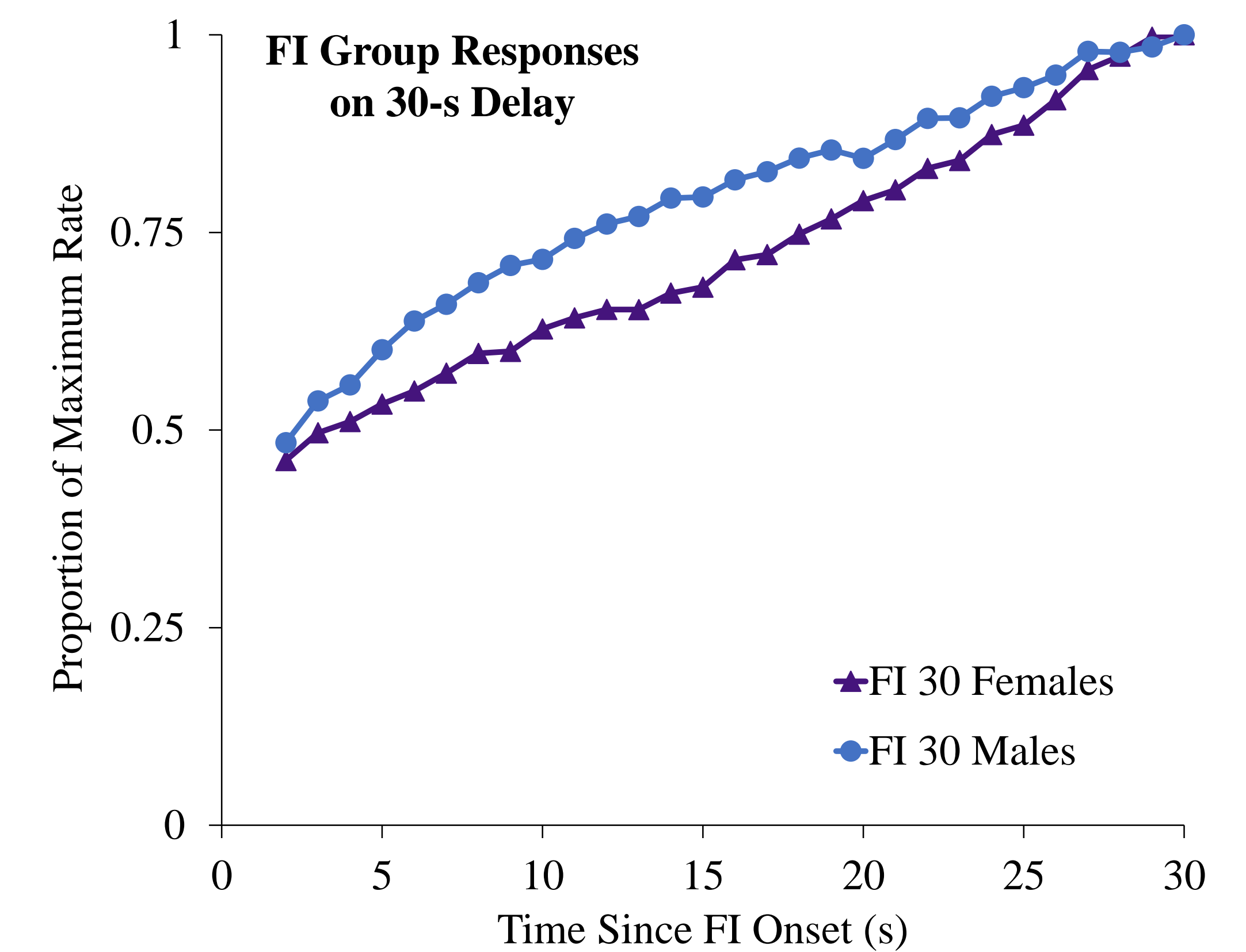

Figure 4. Response rate during 30-s fixed-interval intervention. Females displayed a steeper increase in response rates over the FI 30-s schedule, suggesting they were timing the 30-s delay more precisely than the males.

DISCUSSION

- The FI intervention increased LL choices compared to the ND control, regardless of sex, but females showed a decreased sensitivity to delay and a greater intervention effect.
- Acquisition analyses indicated that the intervention decreased preference for smaller rewards in males and females on the first day of the choice task, but females remained more resistant to the SS choice while males did not.
- The sex differences may have stemmed from differences in timing processes for males and females.
- However, the strong SS preference in the FI males in this study is unusual compared to previous research conducted in our lab.[6]
- Further studies should elucidate the differences between sexes and their resistance to temptation of an immediate reward.

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