Abstract

Second order schedules of token reinforcement under fixed-ratio and variable-ratio exchange schedules have been investigated with nonhuman organisms (Webbe & Malagodi, 1978; Foster, Hackenberg, & Vaidya, 2001), but despite the widespread use of token systems with children with disabilities, research evaluating the effects that token exchange schedules have on human performance has yet to be published. The purpose of this study is to extend the basic literature on token economies by comparing the performance of four children with autism under fixed-ratio and variable-ratio token exchange schedules using a multi-element design within a parametric analysis.

Token economies are one of the most important technologies used by behavior analysts. They have been shown to be effective in changing behavior with different populations (Matson & Boisjoli, 2009), and are considered to be among the most successful behavioral technologies (Hackenberg, 2009). Despite their success and popularity, few applied studies have looked beyond the fundamental mechanisms involved in using them most effectively. For example, would using variable-ratio token exchange schedules produce higher rates of behavior than fixed-ratio exchange schedules?

Webbe and Malagodi (1978) investigated rates of behavior under different token exchange schedules with rats. Lever pressing produced tokens on a fixed-ratio 20 schedule, and token exchange was contingent on fixed-ratio 6 tokens (rats could exchange tokens for food after every 6 tokens earned). They then changed the schedule to a variable-ratio 6 token exchange schedule. The authors found that response rates during the variable-ratio exchange schedule were higher due mostly to shorter and less frequent pre-ratio pauses (time before the initiation of each new sequence).

Foster et al. (2001) compared the effects of fixed-ratio (FR) versus variable-ratio (VR) token exchange schedules using a multiple schedule within a parametric analysis with pigeons. The purpose of their study was to replicate and extend previous research by Webbe and Malagodi (1978). Pigeons earned tokens on an FR50 production schedule (i.e., every 50 pecks resulted in a token). Then they systematically changed the exchange schedule (the number of tokens required to exchange) from 2, 4, and 8, alternating between FR and VR schedules. They found that VR exchange schedules produced higher response rates than FR schedules. These differences increased as the ratio increased. As with previous research, the differences in response rates were mostly due to a lower pre-ratio pause in the VR schedules.

The purpose of this study is to evaluate effects of fixed-ratio versus variable-ratio token exchange schedules on rates of behavior with children with autism.

**Method**

**Participants and Setting**

Participants will be 4 to 6 children with autism recruited from The Scott Center for Autism Treatment, a behavioral-based autism treatment center located at Florida Institute of Technology. Sessions will be conducted at a table in the participant’s regular therapy room. The participant and the experimenter will sit at a table, while one to two data collectors will sit about 10 feet away. This research is expected to be completed within 9 to 12 months.

**Pre-Experimental Procedures**

**Color preference assessment***.* Because the color of the token board will be used to signal each condition, it is important to control for color preference to ensure the rates of responding in a particular condition are not influenced by the color of the token board. To minimize potential color bias, we will conduct a color preference assessment, using a paired-stimulus preference assessment (Fisher et al., 1992) to identify three moderately preferred colors; with each color being assigned to a specific condition (training/reinforcer assessment, fixed-ratio condition, and variable-ratio condition). Three moderately preferred colors (selected 30% to 60% of opportunities) will be used to create token boards for token training, variable-ratio token exchange condition, and fixed-ratio token exchange condition.

**Dependent Variables**

The primary dependent variable will be rate of target behavior. Rate will be calculated by dividing the frequency of responses by total amount of time during which the participant is able to earn tokens (total session time-token exchange time). Pre-ratio pause, defined by the time between the beginning of a token interval and the first target response, will be a secondary dependent measure. The target response will be an arbitrary, mastered task, and will vary across participants depending on their skillset.

**Experimental Design and Procedures**

A parametric analysis will be conducted to compare response rates under fixed and variable exchange schedules using an ABABAB with an embedded multi-element design to evaluate the fixed-ratio and variable-ratio comparison. All A conditions will be baseline conditions. The first B condition will compare FR5 to VR5 token exchange schedules, the second B condition will compare FR10 to VR10 token exchange schedules, and the final B condition will compare FR15 to VR15 token exchange schedules.

**Procedures**

***General procedures.*** Prior to each session, the therapist will provide a rule specifying the contingency in place (e.g., “you can do this [as she modeled the response], and if you do, you get a token. Try it”). The participant will then be exposed to the contingency. The therapist will then prompt the participant to complete one correct response and then provide the appropriate consequence.

***Baseline*.** During baseline sessions, the therapist will sit at the table but deliver no consequences contingent on the target response. No board or tokens will be present during this condition. Sessions will be terminated after 5 min, or after 3 min elapse with no responding.

***Fixed ratio vs. variable ratio exchange schedule*.** During this condition, we will compare fixed and variable exchange schedules (5, 10, and 15). To assist with discrimination of the exchange schedules, a different color token board will be used for the variable-ratio and fixed-ratio conditions. For all sessions across all conditions (fixed- and variable-ratio sessions), prior to pre-exposure and each token interval, we will conduct a brief MSWO in which the first item selected will serve as the back-up reinforcer. Following each target response, the therapist will place a token on the token board and say, “token.” We chose to have the therapist place the token on the board rather than the participant to ensure the delivery of a token will not compete with the completion of the target response. Once the participant earns the predetermined number of tokens (which will vary depending on the predetermined exchange schedule), the therapist will say, “Time to exchange,” remove the task items, and present the token board. During this exchange period, each token will be exchanged for one edible. After the participant exchanges all earned tokens, another brief MSWO will be conducted and the edible chosen will be used in the next token exchange. The token exchange schedule for the variable-ratio schedules will be determined by using a random number generator. A number between one and double the amount of the schedule will be randomly selected. For example, during the VR 5 condition, the number of tokens required to earn before exchange will be three numbers between 1 and 10. Sessions will be terminated after three exchanges or after three minutes elapse with no responding.

References

Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992).

Acomparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis, 25*, 491-498. doi:  [10.1901/jaba.1992.25-491](http://dx.doi.org/10.1901/jaba.1992.25-491%22%20%5Ct%20%22pmc_ext)

Foster, T., Hackenberg, T., & Vaidya, M. (2001). Second-order schedules of token reinforcement

with pigeons: effects of fixed- and variable-ratio exchange schedules. *Journal of the Experimental Analysis of behavior*, *26*, 159-178. doi:[10.1901/jeab.2001.76-159](http://dx.doi.org/10.1901/jeab.2001.76-159%22%20%5Ct%20%22pmc_ext)

Hackenberg, T. D. (2009). Token reinforcement: a review and analysis. *Journal of the*

 *Experimental Analysis of behavior*, 257-286. doi: 10.1901.jeab.2009.91-257.

Higbee, T. S., Carr, J. E., & Harrison, C. D. (2000). Further evaluation of the multiple-stimulus

 preference assessment. *Research in Developmental Disabilities, 21*, 61-73.

Matson, J., & Boisjoli, J. (2009). The token economy for children with intellectual disability

and/or autism: a review. *Research in Developmental Disabilities, 30*, 240-248. doi:10.1016/j.ridd.2008.04.001

Sundberg, M. L. (2008). *VB-MAPP Verbal Behavior Milestones Assessment and Placement*

*Program: a language and social skills assessment program for children with autism or other developmental disabilities : guide*. Concord, CA: AVB Press.

Webbe, F.M, & Malagodi, E.F. (1978). Second-order schedules of token reinforcement:

Comparisons of performance under fixed-ratio and variable-ratio exchange schedules. *Journal of the Experimental Analysis of Behavior, 30*, 219-224. doi:  [10.1901/jeab.1978.30-219](http://dx.doi.org/10.1901/jeab.1978.30-219%22%20%5Ct%20%22pmc_ext)