Toward a Functional Analysis of Social Behavior

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National Autism Conference, Penn State 2019
Social/evolutionary psychology
Behavioral economics
Behavior analysis
Comparative psychology
Behavioral neuroscience
aims

• review social behavior literature
• develop a functional analysis
• priorities for research and application
Keller & Schoenfeld (1950)

Social behavior may be described as behavior for which the reinforcing or discriminative stimuli are, or have been, mediated by the behavior of another organism (pp. 257-258).
social behavior

Skinner (1953)
...the behavior of two or more people with respect to one another or in concert with respect to a common environment (p. 279).
behavior is social when..

the behavior of others serves important behavioral functions (e.g., Sd, SR+) and/or participates in interdependent contingencies.

What are these behavioral functions and contingencies?
Functional Analysis

Two meanings of functional

- evolutionary: selected by phylogenetic contingencies
Altricial
One-day-old meadowlark

Precocial
One-day-old ruffed grouse
social motivation

social attention

social reinforcement
Functional Analysis

Two meanings of functional
• evolutionary: selected by phylogenetic contingencies
• behavioral: selected by ontogenetic contingencies

the variables of which behavior is a function

Skinner’s “natural lines of fracture...”
reinforcement functions
Social reinforcement

- Access to another rat serves as social SR+
  - Evans et al. (1994)
  - Everitt (1990)
  - Hauser & Gandelman (1985)
  - Lee et al. (1999)
  - Trezza et al. (2011)
  - Wilsoncroft (1969)
Rats

- highly social species
- live in groups, derive many benefits from social behavior
Empathy and Pro-Social Behavior in Rats

Inbal Ben-Ami Bartal,¹ Jean Decety,¹,²,⁴ Peggy Mason³,⁴
Interpretations

Empathy

Social reinforcement

• social release as an operant
Is social contact a reinforcer?

- PR schedules
- Extinction
- Comparisons to food
- Motivational variables
To free, or not to free: Social reinforcement effects in the social release paradigm with rats

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ABSTRACT

The present research measured social reinforcement in rats using a social-release procedure in which lever presses permitted the access to a familiar social partner. The work requirements for reinforcement increased systematically according to a progressive ratio (PR) schedule. Social and food reinforcement values were compared across blocks of sessions (Experiment 1) and concurrently within the same sessions (Experiment 2). To assess motivational effects, response and reinforcement rates for both reinforcer types were studied under food restriction, social restriction, and combined food and social restriction. Responding was maintained by both reinforcers, albeit at substantially higher levels for food than for social access. Responding for social access decreased to low levels under extinction conditions, demonstrating functional control by the social reinforcement contingency. Sensitivity to social restriction was seen in some conditions in Experiment 2, in which social reinforcer were paired earlier in the session (or lower food prices) under social restriction than under the other deprivation conditions. Altogether, results are consistent with a social reinforcement conceptualization, and demonstrate an important role for social contact in social release behavior. The study demonstrates a promising set of methods for analyzing and quantifying social reinforcement.

1. Introduction

Prosocial behavior has been defined as behavior that produces benefits for another (Cronin, 2012; West et al., 2007), but the mechanisms are not well understood. To the extent that behavior for the good of another means costs to the individual, instrumental (cost-benefit) models must assume additional benefits for the individual that outweigh the costs. In some cases, the benefits to the individual are readily apparent, as in some forms of cooperation, with mutual benefit for both organisms (Dema and Carter, 2009; Isopel and Popik, 2011; Plozni et al., 2011; Tan and Hackenberg, 2016).

In other cases, the benefits to the individual are less apparent, as in some forms of what might be termed helping or rescue behavior, in which one organism releases another from a trap or restraint (Ben-Ami Bartal et al., 2011; Newbail et al., 2008). In the Ben-Ami Bartal et al. study, for example, two unfamiliar (cage-mate) rats were placed in an arena, one of which began each session in a transparent tube-like restraint. A second rat was unrestrained, and could move freely around the rest of the arena. A latch on one side of the restraint could be lifted, releasing the restrained rat, for the remainder of the 60-min session. No explicit training was provided, though the response was prompted by lifting the door halfway up at the 30-min mark. After an average of 7 sessions, 23 of 30 rats acquired the door-opening response, and once the response was acquired, it generally continued to occur in subsequent sessions and with shorter latencies (i.e., earlier in the session). The door-opening response was also repeated, in that it occurred only under conditions with a live rat in the restraint; it did not occur when the restraint was empty or occupied by a toy rat.

Door opening under these conditions thus appears to be a learned prosocial response, but how best to explain it? Ben-Ami Bartal et al. (2011) favored an empathy-based explanation, according to which distress is socially transmitted, from the restrained to the free rat via social contagion; this, in turn, motivates prosocial behavior (see also Ben-Ami Bartal et al., 2011; Sato et al., 2015). By this view, the prosocial behavior occurs costs that exceed any obvious benefit to the individual, and must therefore be due to altruism.

An alternative, and far simpler, explanation is that door opening for the unrestrained rat is an operant response, established and maintained by social reinforcement, access to the other rat (Schweitz et al., 2017; Gilberg et al., 2014). This possibility was considered but rejected by Ben-Ami Bartal et al. (2011), largely on the basis of a control condition, in which door opening permitted release but prohibited direct social...
Is social contact a reinforcer?

- PR schedules
- Extinction
- Comparisons to food
- Motivational variables
- Demand
- Preference
Vanderhooft, Tan, & Hackenberg (forthcoming). Mexican J of Behavior Analysis
Social preference

- FR 1 (single press opens either door)
- 45-s access to side chamber

prefer social

prefer non-social
Choice between social reinforcers

- familiar rat vs stranger rat
Toward a Behavioral Analysis of Joint Attention

prefer social

prefer non-social
Evaluating the stability, validity, and utility of hierarchies produced by the Social Interaction Preference Assessment

SAMUEL L. MORRIS AND TIMOTHY R. VOLLMER

Assessing preference for types of social interaction

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To date, few researchers have evaluated methods for assessing preference for social interactions. Due to concerns that commonly used stimulus preference assessment methods may be inappropriate, or at least cumbersome, for the assessment of social reinforcers, we developed and evaluated a new method of assessing preference for social interactions. A social interaction preference assessment (SIPA) and a concurrent operant reinforcer assessment were conducted with five participants diagnosed with autism spectrum disorder. A differentially preferred and reinforcing social interaction was identified for all five participants. The SIPA procedures, results, and the implications of these results are discussed.

Key words: autism spectrum disorders, preference assessment, reinforcer assessment, social interaction
Morris & Vollmer (2019)

• preference assessment
• 5 children with ASD
• paired cards with different social SR+
discriminative functions

when social interaction serves SR+ functions, it usually does so in the presence of other stimuli, both social and non-social.
An operant analysis of joint attention and the establishment of conditioned social reinforcers

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Behavioral Interventions
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AN OPERANT APPROACH TO TEACHING JOINT ATTENTION SKILLS TO CHILDREN WITH AUTISM

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Holth et al. (2009) compared two procedures:

- stimulus pairing
- 3-term contingency

$SD$ procedure superior in 6/7 cases.
Isaksen & Holth (2009) used same procedure to establish adult attention as SR+

SR+ for attention (social orientation)
SD for accessing a preferred SR+

developed joint attention skills

crucial building block in emerging verbal skills
social discriminative stimuli

$S^D$ as another organism

$S^D$ as the behavior of another organism
THE USE OF RATS AS DISCRIMINATIVE STIMULI
John R. Husted and Frank S. McKenna
DE PAUW UNIVERSITY
$S^D$ as behavior of another

observational learning

- correspondence relations
functional subtypes of observational learning

social facilitation

social enhancement

observational conditioning

respondent

operant

imitation
social facilitation

presence of another evokes behavior that contacts new contingencies
OBSERVATIONAL EFFECTS ON THE PREFERENCES OF CHILDREN WITH AUTISM

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Children with an autism spectrum disorder (ASD) may play with limited objects or toys, making it difficult for teachers to identify reinforcers to use in teaching new skills. The goal of this study was to alter children’s preferences from highly preferred toys to toys that were originally less preferred using an observational pairing procedure. Child participants observed a preferred adult playing with toys that were initially less preferred by the child. This intervention resulted in a shift in preference toward the item manipulated by the adult. Maintenance of the changed preference was idiosyncratic across participants. Results suggest a procedure for expanding the range of items that students with ASD will select.

Key words: autism, conditioned reinforcement, observational learning, preference, reinforcement
Leaf et al. (2012)

Baseline

Observation trials

Choice trials

altered preferences consistent with the model
controlling variables

• alter SR+ value?

• facilitate contact with SR+?

directions for research

practical implications
imitation

matching response topography
Variables known to affect imitation

• SR+ for demonstrator
• motivation for demonstrator
• delay
• familiarity
human vs nonhuman

- differ in complexity
- generalized vs specific

exception: “enculturated” apes
Causal knowledge and imitation/emulation switching in chimpanzees (Pan troglodytes) and children (Homo sapiens)

https://www.youtube.com/watch?v=JwwclyVYTkk
human vs nonhuman

imitation vs emulation (observational conditioning)
different controlling variables
human vs nonhuman

differences in degree
human imitation is pervasive
a double-edge sword..
social contingencies

interdependent contingencies
Cooperation

Behavior that produces benefits for another
Prosocial behavior

• building block of culture

• challenges cost-benefit models
interdependent contingencies

Cooperation ↔ Competition
Mutualism
Crawford (1937)

Mutual pulling produced food for both chimps
Elephants know when they need a helping trunk in a cooperative task

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Elephants know when they need a helping trunk in a cooperative task

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Cooperative problem solving in a social carnivore

Christine M. Drea a, b, c, *, Allisa N. Carter d, 1
• Mutual reinforcement (food) for lever presses < 0.5 s apart
• Alternating IRT as social unit
• Yoked-control schedules
  – Free food (VT) as control for food delivery rate
  – Earned food (VI) as control for food rate and contingency
Coordinated responding decreased substantially when the mutual reinforcement contingency was removed.
Functional Analysis of Mutual Behavior in Laboratory Rats
(Rattus norvegicus)

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Three pairs of rats were trained to synchronize their lever pressing according to a mutual reinforcement contingency, in which alternating lever presses that fell within a 750-ms window were reinforced with food. In Experiment 1, rats worked in adjacent chambers separated by a transparent barrier, and the effects of the mutual reinforcement contingency were compared with those under yoked-control conditions that provided the same rate of food reinforcement but without the temporal coordination requirement. In Experiment 2, coordinated behavior was compared with and without a barrier, and across different barrier types: transparent, opaque, wire mesh. In Experiment 3, the effects of social familiarity were assessed by switching partners, enabling a comparison of coordinated behavior with familiar and unfamiliar partners. The overall pattern of results shows that the coordinated behavior of 2 rats was (a) maintained by mutual reinforcement contingencies, (b) unrelated to the type or presence of a barrier separating the rats, and (c) sufficiently flexible to adjust to the presence and behavior of an unfamiliar partner. Taken as a whole, the study illustrates a promising approach to conceptualizing and analyzing behavioral mechanisms of mutual behavior, an important component of an integrative study of social behavior.

Keywords: social behavior, cooperation, temporal coordination, mutual reinforcement, rats

Intraspecies cooperation is widespread in the animal kingdom, and includes cooperative hunting, territory defense, reciprocal grooming, and food sharing, among others (Roberts, 2005; Stevens, Cushman, & Hauser, 2005). Until relatively recently, much of the comparative work on cooperation had been conducted with primates (e.g., Chalmers & Gallo, 1995; Chalmers, Landeux, Brandtlian, & Gallo, 1997; Chalmers, Visalberghi, & Gallo, 1997; Cronin, Kurnat, & Snowdon, 2005; Hiraldo, Karonishima, & Fujita, 2005; Hiraldo & Fusa, 2007; Mendes & de Waal, 2000; Visalberghi, Quarrante, & Tranchida, 2000). The cross-species analysis of cooperation has proliferated in the past decade, however, and now includes, in addition to apes, corvids (Steed, Clayton, & Emery, 2008), African gray parrots (Péron, Rat-Flucher, Laiot, Nagle, & Bovet, 2011), wolves (Müglinger, Kottenchla, Huber, Range, & Vitrani, 2009), hyenas (Dera & Carter, 2009), dogs (Birrer, Rie, Call, & Tomassini, 2013; Ostojic & Clayton, 2014), elephants (Piotnik, Liar, Supachokkachan, & de Waal, 2011), and rats (Lopuch & Popik, 2011; Rutte & Taborsky, 2007; Schuster & Petriherr, 2004).

The present study was concerned with a type of cooperation termed mutualize, in which socially coordinated behavior produces gains for both animals. Experimental study of mutual behavior dates to a study by Crawford (1977), in which coordinated responding of two chimpanzees was required to produce food for both. In the Crawford study and in the majority of subsequent replications, the mutual response involved pulling a receptacle within reach of both animals (e.g., Hiraldo & Fusa, 2007; Mendes & de Waal, 2000; Müglinger et al., 2009; Péron et al., 2011; Piotnik et al., 2011; Rutte & Taborsky, 2007). Other variations utilize a temporal coordination task, in which animals are required to respond synchronously on two separate operands (e.g., Chalmers & Gallo, 1995; Cronin et al., 2005; Lopuch & Popik, 2011; Visalberghi et al., 2000). In the Lopuch and Popik (2011) study, for example, pairs of rats in adjacent chambers were trained to respond in temporal synchrony (within 2000 ms of each other) to produce mutual sucrose reinforcement. Coordinated responding, defined as the proportion of responses that met the mutual reinforcement contingency, was established and then maintained across a series of conditions that manipulated the presence and
• (simultaneous hole pokes) mutual responses produced jelly beans

• coordinated responding developed in most pairs

• broke down with inequities in earnings
An audit response allows access to an existing score from a subject's own performance (self audit) or from his coactor's performance (coactor audit). A previous study found that social stimuli (coactor present) increased audits relative to a non-social (no coactor) condition. The increase, designated a social-stimulus effect, was found to be due more to the coactor's score than to his mere presence. This finding suggested that the difference between self and coactor scores might affect the size of the social-stimulus effect. In the present study, six pairs of human subjects matched-to-sample for points that were exchangeable for money. During a session, matching-to-sample problems were distributed so that a subject's score was ahead, behind, or about even with his coactor's score. The even condition produced the largest social-stimulus effects, i.e., the most audits that could not be attributed to non-social variables such as time or number of problems. The even condition may have produced the largest social-stimulus effects because it was the only condition where the major social reinforcer (being ahead) could be both present or absent and, consequently, the even condition was the only one where audits had a discriminative function with respect to the presence of the major social reinforcer.
Vukelich & Hake (1974)

- MTS task with audit option
  - self: checking one’s own score
  - other: checking other’s score
- manipulated inequity in earnings
- self-audits occurred occasionally but other audits were by far the most frequent
- auditing highest when inequity was low, and lowest when inequities were high

interpersonal audit: audits from both < 0.5 s fundamental social unit
Resource exchange: the contingencies of sharing and trust
explanations

kin selection

reciprocity
reciprocity

- direct: help who has helped you (tit-for-tat)
- indirect: help who has helped others (reputation-based)
- generalized: help if you have been helped (upstream reciprocity)
Focal rat (F) produces food for partner (P)

Manipulated history of help

Rats with a history of being helped were far more likely to help than those not receiving help
Reciprocal food sharing

• Rats produce food for each other, but not for themselves

• Food was produced for the partner on FR 1 with alternating roles of producer and receiver

• Increased the length of producing and receiving components across blocks of sessions
Reciprocal responses across conditions

Responses/reinforcers prior to switch
Correlated pay-offs are key to cooperation

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The general belief that cooperation and altruism in social groups result primarily from kin selection has recently been challenged, not least because results from cooperatively breeding insects and vertebrates have shown that groups may be composed mainly of non-relatives. This allows testing predictions of reciprocity theory without the confounding effect of relatedness. Here, we review complementary and alternative evolutionary mechanisms to kin selection theory and provide empirical examples of cooperative behaviour among unrelated individuals in a wide range of taxa. In particular, we focus on the different forms of reciprocity and on their underlying decision rules, asking about evolutionary stability, the conditions selecting for reciprocity and the factors constraining reciprocal cooperation. We find that neither the cognitive requirements of reciprocal cooperation nor the often sequential nature of interactions are insuperable stumbling blocks for the evolution of reciprocity. We argue that simple decision rules such as ‘help anyone if helped by someone’ should get more attention in future research, because empirical studies show that animals apply such rules, and theoretical models find that they can create stable levels of cooperation under a wide range of conditions. Owing to its simplicity, behaviour based on such a heuristic may in fact be ubiquitous. Finally, we argue that the evolution of exchange and trading of service and commodities among social partners needs greater scientific focus.
Resource sharing is most probable when...

- costs to individual ("donor") are low
- benefits to the other ("receiver") are high
- frequent opportunities for reciprocal behavior
- correlated payoffs are salient
MAGNITUDES OF SCORE DIFFERENCES PRODUCED WITHIN SESSIONS IN A COOPERATIVE EXCHANGE PROCEDURE

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Interest centered on maximal score differences produced within sessions during two-party exchange. Subjects chose between earning money independently or through potentially higher-paying exchange. In the exchange option, only one person could produce points for the other on a trial. Because each exchange response ("give") required the giver to forego earning points independently, the larger the score difference produced (i.e., the further ahead in earnings the other person was put), the greater the reduction in the giver's earnings if the other person did not reciprocate. Results showed that scores were usually equal at the end of each session, and that subjects maintained close equality of scores throughout each session. When a response-cost contingency that punished the alternation of giving was introduced, however, large within-session score differences developed. These large differences continued to be produced after the response-cost contingency was removed. Finally, when subjects were told that the session could end at any moment, score differences were sharply reduced, indicating that production of score differences remained under the control of discriminative stimuli associated with the likelihood of reciprocation. The study suggests that with appropriate procedures, an experimental analysis of behavioral phenomena associated with the concept of "trust" may be possible.

Key words: score correspondence, equity, cooperation, exchange, response cost, response preference, dyads, pushbuttons, humans

exchange expansion and "trust"
Matthews (1977)

non-social/individual

social/exchange

exchange expansion: trials separating reciprocity
all else equal, small exchange units prevail

this reduces inequity/cheating

when exchange becomes costlier, greater inequity is tolerated

but returns to shorter exchange bouts when session length is unpredictable

Trust but verify...
Competition

- Behavior that produces benefits for oneself at the expense of another
- SR+ is divided unequally depending on individual performance
COMPETITIVE FIXED-INTERVAL PERFORMANCE IN HUMANS

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Two persons responded in the same session in separate cubicles, but under a single schedule of reinforcement. Each time reinforcement was programmed, only the first response to occur, that is, the response of only one of the subjects, was reinforced. "Competitive" behavior that developed under these conditions was examined in three experiments. In Experiment 1 subjects responded under fixed-interval (FI) 30-s, 60-s, and 90-s schedules of reinforcement. Under the competition condition, relative to baseline conditions, the response rates were higher and the pattern was "break-and-run." In Experiment 2, subjects were exposed first to a conventional FI schedule and then to an FI competition schedule. Next, they were trained to respond under either a differential-reinforcement-of-low-rate (DRL) or fixed-ratio (FR) schedule, and finally, the initial FI competition condition was reinstated. In this second exposure to the FI competition procedure, DRL subjects responded at lower rates than were emitted during the initial exposure to that condition and FR subjects responded at higher rates. For all subjects, however, responding gradually returned to the break-and-run pattern that had occurred during the first FI competition condition. Experiment 3 assessed potential variables contributing to the effects of the competitive FI contingencies during Experiments 1 and 2. Subjects were exposed to FI schedules where (a) probability of reinforcement at completion of each fixed interval was varied, or (b) a limited hold was in effect for reinforcement. Only under the limited hold was responding similar to that observed in previous experiments.

Key words: competition, fixed-interval competition schedule, limited-hold procedure, break-and-run response pattern, lever press, humans
Buskist & Morgan (1987)

Competitive FI schedules
first response by either subject was SR+
manipulated FI duration
30 s, 60 s, 90 s

Compared to simple (non-competitive) FI
competitive FI

simple FI

Fig. 2. Representative cumulative records of FI competition performances. The top row of records is from the 71-day competition condition, the middle row is from the FI-60 condition, and the bottom row is from the FI-90 condition. Numbers under each record indicate their duration.
EFFECTS OF REWARD DISTRIBUTION AND PERFORMANCE FEEDBACK ON COMPETITIVE RESPONDING

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To implement competitive contingencies, one must select a distribution of unequal rewards and a schedule of feedback for competitors regarding one another’s performance. This study investigated three bases for distributing rewards and two performance feedback conditions. Pairs of college students competed over a series of 2-min contests in which the competitive response was a knob pull. A sum of money was divided using a proportional distribution or one of two fixed reward distributions. In the proportional distribution, a subject’s proportion of the sum was his or her proportion of the total number of responses. The two fixed distributions were divisions of 100%/0% or 67%/33%. Also, in every contest either subject could make a response that would end the contest prematurely and give both subjects the same amount—a sum equal to 33% of the competitive total. In the two feedback conditions, cumulative responses by each subject were either shown to both subjects during the contest or were not shown. The proportional distribution was clearly superior to either of the fixed distributions in number of responses produced across contests. The proportional distribution with feedback produced the largest number of competitive responses, and the 100%/0% distribution without feedback produced the smallest number. Differences among distributions typically emerged only during later blocks of contests. Fixed distributions of rewards often produced decelerating rates of responding, with losing competitors ending the contests before they were completed. Response-rate decreases were greatest for pairs in which the 2 subjects differed most in their response rates and proportion of wins. The presence of feedback had a small effect, increasing responding for some pairs in the 100%/0% distribution. Performance patterns were interpreted in terms of the consequences arranged for the individual participants by the reward distributions and differences in performance between competitors.

Key words: competition, reinforcement contingencies, reward distributions, performance feedback, knob pull, college students
Schmitt (1998)

2-min contests

payment contingencies

100%-0%
67%-33%
proportional to response rate

escape option: both players get equal SR+
Schmitt (1998)

Competitive rates highest under Proportional

Escape was highest with greater discrepancies in earnings
Matrix games

Prisoner’s dilemma

Ultimatum game

Public goods game
group contingencies

Good Behavior Game
Cooperation is a complex function of many interacting variables, including...

- costs to individual
- benefits to the other
- non-cooperative alternatives
- opportunities for reciprocal behavior
- feedback (audits) for self and others
Competition, too, is a complex function of many interacting variables...

- benefits to individual
- costs to the other
- opportunities for reciprocal behavior
- feedback (audits) for self and others

- non-competitive alternatives
- criteria for evaluating/ranking performance
- relative SR+ distribution
  - fixed v proportional
Conclusions

- Methodological
- Comparative
- Interdisciplinary
- Translational
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