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THEORETICAL ARTICLE

Selection of Words in Ontogeny

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Abstract

This article suggests a framework for integrating a conceptual and an empirical approach to understanding human speech. Verbal activities may be understood as a result of conjoint phylogenetic and ontogenetic selection processes. The present article situates an experimental procedure investigating verbal activities as a function of ontogenetic events in the larger context of Darwinian selection. In this experimental procedure, the experimenter uttered "hmm" and "yes" contingently and contiguously on a participant's mentioning of predefined words. To test if the experimenter's verbal activity modified the participant's rate of those words, 63 Norwegian participants reported individually on video recordings. Resembling the results of previous studies, cumulative relative frequency distributions of target word rates showed that three of four target words occurred at a higher rate when the experimenter uttered "hmm" and "yes" during a participant's report than when she was silent. Methodological challenges of investigating the selection of verbal activities by their contingencies with Phylogenetically Important Events are discussed.

Keywords Speech · Ontogeny · Selection of behavior · Operant selection · Phylogeny-ontogeny relation

Psychology has been depicted as "a confusing patchwork of inconsistent and arbitrary explanatory attempts" (Tonneau & Sokolowski, 2000, p. 159; Tooby & Cosmides, 1992). Relating psychology to evolutionary biology might diminish the arbitrariness of psychological principles by grounding them in well-established evolutionary theory (Barkow et al., 1992; Tonneau & Sokolowski, 2000). This bringing together can happen (1) "vertically" by focusing on causal dependencies among behavioral and evolutionary processes, and (2) "horizontally" by explicating the commonalities between underlying processes (Tonneau & Sokolowski, 2000). In this article, I make explicit these dependencies (1) and commonalities (2) in an attempt to develop a monistic, naturalistic account of human language that is devoid of mentalistic theorizing. To integrate verbal behavior with evolutionary theory, I combine conceptual and experimental work.

Evolution can be regarded as a domain general process going beyond natural selection. In particular, I argue for an understanding of behavior change during the lifetime of the organism as a result of variation and selective recurrence of activities. I have earlier suggested to apply the idea of selection of some behavior over other during the lifetime of an organism to verbal interchanges (Simon, 2018b, 2020, 2024). Directed change of verbal behavior in an experiment relates to the naturally occurring selection of behavior during the lifetime of the individual as Darwinian selection relates to artificial breeding. That means, just like selection of genes over generations can occur naturally and artificially,[1] the selection of behavior during a lifetime occurs both naturally and directed by humans such as in experiments, through nudging techniques, in interventions, or through other attempts of behavior modification. We could discontinue the artificial selection of genes from generation to generation and the artificial selection of behavior in a lifetime but selection of both would still occur naturally. We utilized the effects of artificial breeding before we knew about Darwinian selection, and we utilized the effects of behavior modification before we started viewing behavior change as resulting from ontogenetic selection processes.

[1] The distinction between *artificial* and *natural* is done differently dependent on context. Here, I define *artificial* as directed by an external entity, usually humans. In other contexts, it is the method rather than "who is taking the decision" that makes the distinction. For example, when organisms do not become pregnant "naturally" but through fertility treatment such as "artificial" insemination.

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In addition to giving an understanding of how a "traditionally designed" experiment can be understood in a broader conceptual narrative, the secondary purpose of this study is to present experimental results that add to the existing body of data on verbal interactions. Because a "framework" is superordinate to any of its parts, the experiment is subordinate to the framework in this article. The experiment is reported to propose a link between (a) the subject matter of allocation of time to human verbal behavior, and (b) the conceptual and philosophical literature on selection processes. After introducing the framework, the experiment is reported with a nod to its place in a large research literature on verbal behavior, which does not explicitly connect verbal behavior to the framework. The selectionist framework I present here necessitates my particular experimental setup as little as an attempt to explain natural selection would necessitate presentation of a particular technique used in artificial breeding of animals. Instead, the presentation of my study serves primarily to illustrate how one could approach an understanding of research on verbal behavior within a selectionist framework.

The relation between natural selection and learning in terms of selection of behavior during the lifetime of the individual (Baum, 2012, 2013, 2015, 2017; Baum & Davison, 2014; Simon & Hessen, 2019), gives a framework that can motivate experiments on verbal units of selection and opens up a way for a novel interdisciplinary interpretation of results. As Glenn and Madden (1995) conclude: "although *selectionist* is an adjective often applied to the behavior-analytic paradigm, the serious work of explicating what that means has barely begun" (p. 249; italics in original). In the following, I set out to contribute to an improved understanding of selectionism. In a selectionist framework, natural selection has produced another selection process advancing organisms' fitness[2]: a process of selecting activities during the lifetime of the organism (Skinner, 1981; Staddon & Simmelhag, 1971). Activities that enter into a correlation, or a contingency, with Phylogenetically Important Events (PIEs; Baum, 2012), or events correlating with PIEs, increase or decrease in frequency and/or in duration. That means they take up more or less of an organism's time. PIEs are events that, during our species' history, have gained the power to induce behavior in ontogeny, here defined as the time from conception to death of an individual. They are events such as predation or access to food or mates that can affect fitness.

Selection processes in ontogeny and in phylogeny are relative processes, which implies that not every occurrence of an activity induced by PIEs is advantageous to reproductive success; instead, PIEs induce behavior that advances fitness in the long run and on average. If an activity is in a contingency with a PIE, the likelihood of the occurrence of the activity differs in the presence and in the absence of the PIE (Rescorla, 1968, 1988). The framework comprises two fundamental postulates. The first postulate posits that natural selection has given rise to an additional process that adjusts behavior to its environment. The second postulate suggests that the impact of PIEs results from natural selection. Both postulates center on the causal dependencies between behavioral and evolutionary processes, establishing a "vertical" connection akin to Tonneau and Sokolowski's (2000) distinction (1), mentioned above. Furthermore, both natural selection and the adaptation of behavior to environmental changes during an organism's lifetime can be viewed as selection processes. This emphasizes the commonalities between these processes, forming a "horizontal" connection similar to Tonneau and Sokolowski's distinction (2). Exploring these vertical and horizontal connections carries the potential to facilitate a unified, naturalistic account of human language, without recourse to mentalistic theorizing. This endeavor to integrate verbal behavior and evolutionary theory involves a synthesis of conceptual and experimental approaches.

Activities of humans, who have largely evolved living in groups (Diamond, 2012; Richerson & Boyd, 2005), are selected by a variety of social events (Eibl-Eibesfeldt, 1975). Being smiled at may covary with safety or reproductive success. Many of these social events are ontogenetic proxies of PIEs; that is, they are events that covary with PIEs. For example, a friendly greeting may covary with safety. Money covaries with resources. That is, the covariance makes such events effective. We do not work for money that does not covary with access to resources. Once an event has become a proxy of a PIE, it induces activities such as working, much as the PIEs themselves would (Baum, 2015). A friendly greeting is an example of the subcategory of social PIE-proxies. Receiving money is not necessarily a social event but an example of the broader category of all events (PIE-proxies) that gain control over our behavior through experiences we have in the course of our lifetime.

From a selectionist perspective, behavior is choice, in the sense that behavior consists of allocation of time among various activities (Baum, 2013). Behavior can be measured as time allocation to different activities. Because time is limited, activities compete for the available time. Activities, such as talking about certain topics, take up time. Mentioning a particular word may be understood as a part of "talking about a particular topic" and that can be part of the more extended activity of talking, for example, about a film featuring that topic. If talking time is constant, when talking more exclusively about one topic, one needs to talk less about another topic. If talking time is not constant one might

[2] Biological *fitness* is defined as the average contribution an individual makes to the gene pool of the next generation. This means, it is a quantitative representation of an individual's reproductive success.

talk longer overall when talking more about one topic but that would result in spending less time doing something else (such as working out, sleeping, cooking dinner, etc.) What influences which activities we engage in? In this particular case, what influences what topics we talk about?

When fitness-advantageous PIEs or their proxies correlate positively with an activity, this correlation selects allocation of time to that activity. As effective verbal communication can be assumed to benefit the fitness of individuals living in groups (Kirchner, 1997), many social PIE-proxies can be presumed to occur in verbal interchanges. In accordance with this narrative, if verbal PIE-proxies are made contingent upon a verbal unit, that unit should increase or decrease in rate or extent. This begs the question what may function as a PIE-proxy in a conversation. Conversations can have a range of outcomes that in the long run can affect the fitness of those participating in a conversation, here called interlocutors. Conversations can, for example, lead to persuasion, social bonding, or access to information. To the extent that effective communication in conversations depends on both interlocutors, conversations might be conceived of as a kind of verbal cooperation. Conversations are effective if an interlocutor adjusts what they are saying to the interest or relevance of another interlocutor who guides this process by providing feedback. Thus, such a pattern of feedback is a candidate for a social PIE-proxy that selects, for example, which topics we talk about. If interlocutor A continues listening to what interlocutor B is saying this could be fitness-advantageous for interlocutor B if B was, for example, persuading A of something important to B. Thus, if A's pattern of uttering "hmm" and "yes," was (part of) an advantageous PIE-proxy selecting B's verbal activity, making "hmm" and "yes" utterances contingent on B's verbal activity should increase B's verbal activity. Along these lines, the rate of particular words, that were defined as the dependent variable, was measured in our experiment, and the utterances "yes" and "hmm" were manipulated as the independent variable. Similar studies have been conducted in other frameworks (e.g. Azrin et al., 1961; Salzinger & Feldman, 2013; Simon, 2018a; Wolf, 2008).

The primary purpose of this article is to elaborate on the selectionist view and to give an example of an experiment conducted in this framework. My conceptual argument does not necessitate my particular hypothesis or procedure nor do the data test one conceptual argument against another. The secondary purpose of this article is to demonstrate the impact of one verbal variable on another. Different from the traditional division into conceptual and experimental publications, this article aims at building a bridge between a selectionist view of behavior change during our lifetime and an experimental exemplification of influences on verbal behavior. The goal of the article is to propose an evolutionarily sensible approach to human language that, for example, Catania (2001) and Hayes and Sanford (2014) have pointed out to be a gap in the literature.

Our experimental method modifies procedures previously used in research on the influence of environmental events on speech (for reviews, see, e.g., Eshleman, 1991; Holz & Azrin, 1966; Krasner, 1958; Presti & Moderato, 2016; Salzinger, 1959; Salzinger & Feldman, 2013). Previous studies differ in what independent variable they manipulate and what dependent verbal activity they measure. There is only partial agreement in results, which points to open questions regarding the variables controlling verbal behavior (Salzinger, 2013). Increasing clarity about what variables affect another person's speech is significant for a variety of everyday situations in which one either would like to avoid influencing accounts or would like to increase or to decrease talk about certain topics. Interviewing, witness interrogations, and therapeutic interactions are examples (Holz & Azrin, 1966). It is self-evident that evolved mechanisms may hold implications for practice. The present study sheds light on one of the variables that seem to affect verbal activities.

In his pioneering study on verbal interactions, Greenspoon (1955) asked participants to say "any words they can think of." Data showed large intersubject variability and a statistically significant but small effect of "hmm" utterances on the rate of plural nouns. In replications of Greenspoon's study and in similar experiments, a variety of methodological challenges occurred. For example, observers varied in their ability to provide feedback immediately and correctly (e.g., Azrin et al., 1961; Phillips et al., 1960; Ulrich, 1962). "Hmm" led to an increase of some participants' speech while leading to a decrease of others' (Mandler & Kaplan, 1956).

Further challenges have been to delimit what units to follow with feedback (Salzinger & Feldman, 2013). Not only may participants mumble, but "[v]erbal responses do not necessarily exist in their natural state as isolated units or neatly separated into grammatical classes" (Holz & Azrin, 1966, p. 799). One approach to tackle this problem is to ask the participants to enumerate isolated words instead of inducing them to speak continuously (e.g., Dulany, 1961; Kapostins, 1963; Mandler & Kaplan, 1956; Sidowski, 1954). However, even to provide feedback following a predefined subcategory of listed words, one needs to discern whether "sheep" is a plural noun and if the participant said "rose" or "rows" (Spielberger & De Nike, 1963). To address this ambiguity, a variety of verbal activities have been tested as dependent variables (Das, 2014). Craddick and Leipold (1962) and Wilson and Verplanck (1956), for example, used verbs or adverbs. Verplanck (1955) tested "opinion statements," and, together with Baum, I have analyzed participants' allocation of talking time to two concurrent interlocutors (Simon & Baum, 2017). I have also analyzed how duration of speech varies as a function of active listening responses (Simon, 2018)

Some sources of ambiguity may be limited if context is given, as in continuous speech. We might know from context if a participant says "rose" or "rows." For this reason, and in order to create a more natural situation than one in which a participant lists words, we asked participants to report on the content of a video. However, this did not eliminate all sources of ambiguity. We conducted a pilot experiment using the same procedure and materials as the present one, testing the effect of "ja[3]" and "hmm," (hereafter called "feedback") said contigiously after naming "mental terms" such as thoughts, feelings, or intentions. Challenges in deciding which of the participant's words qualified as words to be followed by feedback made us switch to an exhaustive list of nonmental terms. This exhaustive list specifies one particular group of nouns per trial (e.g., box/container or pigeon/bird), which the experimenter could recognize with certainty. These different nouns are assumed to be indicators of talking about different topics, which may be seen as activities that compete for an organism's time. Talking about a certain topic may be regarded as more likely relevant to fitness than, for example, uttering one or another preposition or an easily interchangeable word. Talking about a certain topic might be fitness relevant because it might have effects on other's behavior such as convincing someone or inducing someone to cooperate; it might warn a relative of danger or improve a child's handling of a risky situation. Our final choice of target words counteracted an additional problem, which had occurred both in our attempts to follow mental terms by feedback and in Greenspoon's (1955), Salzinger and Pisoni's (1958, 1960, 1961), and Wilson and Verplanck's (1956) studies. An initial rate ("operant level") of target words that is too high or too low limits their susceptibility to feedback.

Causally related events often occur in temporal proximity. Hence, natural selection made activities especially susceptible to being affected by closely following PIEs or PIE-related events (Staddon, 1973). Thus, "ja" and "hmm" were uttered in close temporal proximity following the target word. Compared to studies using other dependent variables that challenged immediately giving feedback (e.g. Matarazzo et al., 1960; Salzinger, 1959), our choice of target words allowed for contiguous feedback utterance.

Method

To test whether one interlocutor's utterance of "ja" and "hmm" influences the rate with which another interlocutor utters a certain word, individual participants reported on video recordings they had seen. The experimenter remained either silent or uttered "ja" or "hmm" following each of the participant's mentioning of a predefined word. When talking about the first video recording, each participant was tested either with or without feedback. The two levels of the independent variable were (1) the experimenter's "ja" or "hmm" following each occurrence of the target behavior (defined by saying a certain word), and (2) the experimenter's silence. During their second video report, participants were tested in the other condition. The dependent variable was the rate of mentioning the target word, which was calculated by number of times the predefined word was mentioned, divided by total talking time about the video. The predefined words were dependent on condition, either "big triangle," "small triangle," "pigeon," or "box."

Participants

Sixty-three fluent Norwegian speakers, with a mean age of 18 years, ranging from 10 to 46 years, were recruited at a science fair. Forty-two of them were female, and none of them had any knowledge about behavioral sciences. All of them participated because they were interested in what an experiment on conversations would be like. The experimenters, the participant recruiters, and the coding assistants were 20–32-year-old students attending either the bachelor's program in "Psychology with an Emphasis on Behavior Analysis" or the "Master's Program in Learning in Complex Systems" at Oslo Metropolitan University, Norway (at the time of data collection called Oslo and Akershus University College). They received remuneration and were native Norwegian speakers. Five of these six helpers were female.

Materials

The experiment was conducted in a circular room in the back of a science fair stand. The science fair stand, measuring 9 ft x 16 ft, was colorful, and signs promoted the affiliation to Oslo and Akershus University College and the topic "Research on Conversations." The experimental room was neutrally designed, measured 38 sq ft and was equipped with a round table, three chairs, an audio recording device, a laptop for showing the videos, a laptop for data recording, paper and pencil, passive noise-cancellation earmuffs, a hand counter, and a pile of demographical questionnaires. In a box next to the experimenter lay a pile of informed-consent forms. The form informed the participant about the audio recording, anonymous data analysis, and that they were free to leave the experiment whenever they wanted.

Videos were 60-s excerpts of the animation Heider and Simmel had used in 1944 in their renowned "Experimental Study of Apparent Behavior," and a recording Skinner had made of a pigeon moving a box before hopping on it and reaching up to a yellow object on the ceiling of the experimental chamber ("Pigeon & Red Block," BF Skinner Foundation, 2009).

[3] Norwegian "ja" occurs often where "yes" occurs in English.

Procedure

People who approached the science fair stand were asked if they wanted to participate in a "real experiment" on conversations and were promised that they would be told more about our research afterwards. After the recruiter had confirmed that participants did not know anything about our research and were fluent Norwegian speakers, they were asked if they agreed to be audio recorded. One person declined. He was allowed to participate and learn about our methods, but no data were collected from him. Participants were told that they would watch two videos lasting for 1 min each and that they would then be asked to talk about the videos. When having taken a seat inside the experimental room, the experimenter presented herself and her assistant and asked the participant to sign the informed consent form if they agreed to be audio recorded. The experimenter also pointed out to the participants that they were free to leave the experiment whenever they liked. Then the experimenter asked the participant to put on the earmuffs and started the first video. After the video was finished, the experimenter indicated to the participant to remove the earmuffs and asked the participant to report upon the content of the video. After the first report, the participant was asked to put on the earmuffs again and to watch and report upon the second video. The reports were recorded with a device visible to the participant. Participants' talking time was determined by the participant's first and last word, which was identified in the context, which the audio recordings provided. Talking time started with the first word in the first sentence about the video and ended either when the participant indicated that he or she would not say anymore (by saying something like "that's it" or "this was my story") or with the last word before pausing for 1 s and looking in a questioning manner at the experimenter followed by the experimenter's praise, which ended the session.

The order of videos and assignment of levels of the independent variable was balanced. For half the participants, the experimenter uttered "ja" and "hmm" following either naming "the little triangle" or "the big triangle" in the Heider and Simmel animation and "the pigeon" or "the box" (or similar terms such as "bird" or "container"), in the Skinner Foundation video. Those participants reported the content of the second video to the silent experimenter. The other half of participants received feedback for the same target responses during their second video report, and the experimenter was silent during the first report.

Both the experimenter and the assistant secretly counted the target words with a hand counter hidden under the table to be able to provide approximate experimental results to the participant immediately after the experiment had ended. Following the second report the participant was thanked for participating, was asked to fill out a demographic questionnaire, was debriefed and kindly asked not to talk about the content of the experiment for the remaining time of the science fair.

Results

To examine the effect of the independent variable "verbal feedback" on the dependent variable "rate of mentioning a particular word," counts of target words made during the experiment were analyzed. Recordings of the reports on the Heider and Simmel (1944) animation were coded for their duration and the number of times the participants mentioned the small triangle and the big triangle. The participants' reports on Skinner's pigeon video were coded for their duration and the number of times "the pigeon" and "the box" were mentioned. The reliability with which feedback followed the target words was assessed by coding randomly chosen 10% of the audio recordings for the occurrence of verbal feedback following the target behavior. In this sample, the experimenter uttered "ja" ("yes") once when no target behavior occurred. All other feedback occurred following target words only and all mentioning of the target words was followed by feedback within less than 1 s.

Figures 1, 2, 3 and 4 show relative cumulative frequency distributions of rates of mentioning the small triangle (Fig. 1), the big triangle (Fig. 2), the box (Fig. 3), and the pigeon (Fig. 4), per talking time in seconds. Each frequency distribution represents one group in one condition. In each figure, data points with the dashed lines, representing relative cumulative frequency when no feedback occurred, stem from one group, and data points with the continuous lines representing rates when feedback occurred stem from the other group. Each data point is produced by one participant, that is, distributions do not show behavior of one participant cumulated over time (e.g., as documented by cumulative recorders; Ferster and Skinner, 1957/2015). Instead, points connected by the solid line stem from data accumulated across participants in the feedback condition and points connected by the dashed line stem from data accumulated across participants in the none-feedback condition. Where the dashed line and the continuous line separate, the groups differ.

Data points were calculated[4] by dividing the number of times the targeted responses occurred by the total time the

[4] In detail, cumulative frequencies were calculated using frequency distribution tables, which list the frequencies of each rate in the data set. Adding each frequency in a table to the sum of its predecessors gave the cumulative frequencies, which were converted into the relative cumulated frequency distributions on the y-axes. To generate relative cumulated frequencies from cumulated frequencies, the number of rates equal to or less than the rates on the x-axes were divided by the total number of those rates.

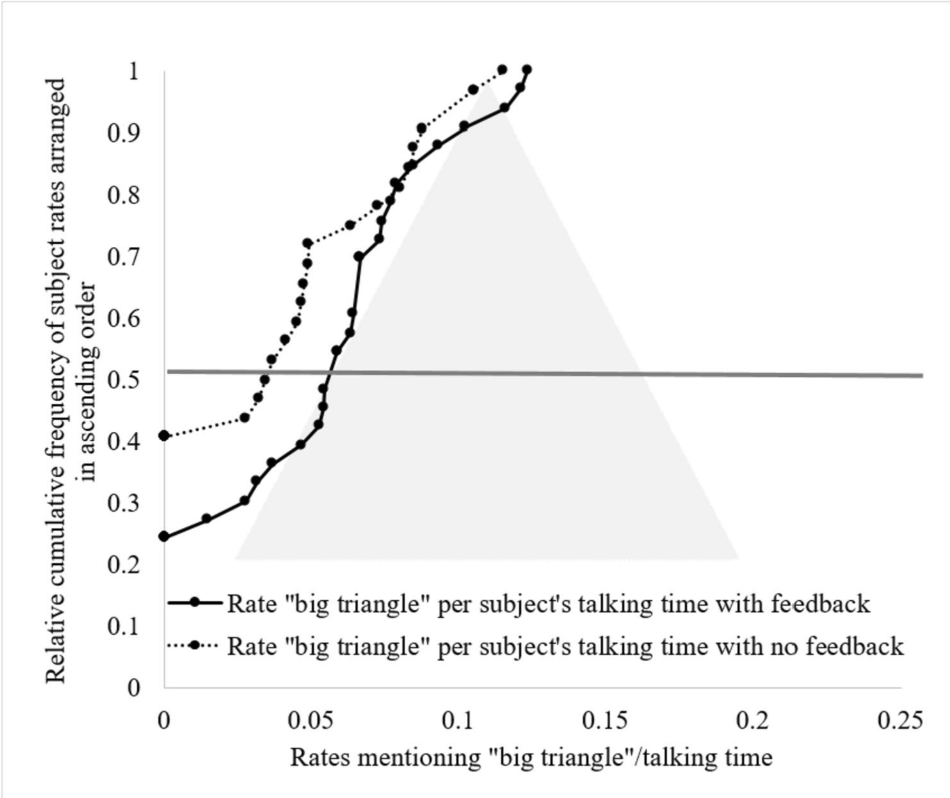

Fig. 1 Relative Cumulated Frequency of Rates of Speaking about the Big Triangle as a Function of Feedback Arranged in Ascending Order. The x-axis shows rates of speaking about the big triangle (number of mentions per total talking time about each video). The y-axis shows the relative cumulated frequency of rates of speaking about the big triangle corresponding to the rate on the x-axis or a lower rate. The gray horizontal line represents the median indicating the central tendency

participant was speaking in order to obtain "rate of targeted occurrences" for that participant. The data points were then plotted on the basis of their "rate place" (lowest to highest rate) among participants in that condition. In Fig. 1, for example, the relative cumulative frequency distributions show the proportion of observations (y-axis) less than or equal to a particular rate of mentioning the big triangle per talking time (x-axis). Multiplied by 100, the relative cumulated frequencies on the y-axes give percentages and can be read as, for example, in Fig. 1, 70% of the feedback rates fell below .07 whereas 70% of the no-feedback rates fell below .05. The horizontal line across from the y-axis at .5 shows the median where the line intersects the curve, separating the higher half of the rates from the lower half, thus providing a measure of the central tendency. Dropping a perpendicular from the intersection between the line and the data curves reveals that in three of four groups of reports (Figs. 1, 2, and 3), the median rate lies at a lower rate (x-axis) for the nonfeedback groups than for the feedback groups. Thus, on a group level, feedback goes along with higher rates of target words per report. However, the median rates on the x-axis indicate that differences are small.

The intersections between the horizontal lines and the curves further indicate that half of all the no-feedback rates in Fig. 1 were less than or equal to .035 "big triangle"/talking time whereas half of the feedback-rates were less than or equal to .055 "big triangle"/talking time or lower. In a parallel manner, one can determine the lower and upper quartile by going up the y-axis to .25 and .75 of the total relative frequency, and then draw a horizontal line to the graph and from the intersection down to the x-axis. By subtracting the upper from the lower quartile, one gets the interquartile range, which gives a measure of dispersion for rates of "big triangle" per talking time with feedback in comparison to rates of "big triangle" per talking time without feedback.

Comparing Figs. 1, 2, 3, and 4 shows that the rate of mentioning the small triangle and the big triangle in the Heider and Simmel (1944) animation was higher when verbal feedback occurred. In addition, the box was mentioned more frequently when feedback was uttered for mentioning the box. Feedback on mentioning the pigeon, however, showed the reverse effect, except when rates of mentioning the pigeon were highest.

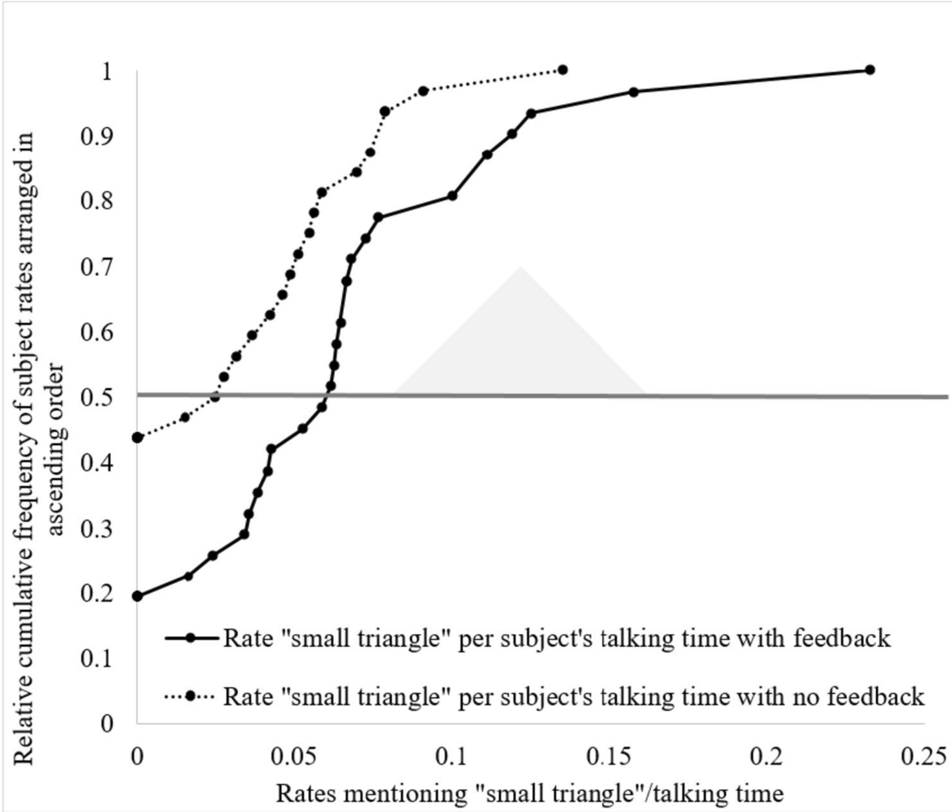

Fig. 2 Relative Cumulated Frequency of Rates of Speaking about the Small Triangle as a Function of Feedback Arranged in Ascending Order. The x-axis shows rates of speaking about the small triangle (number of mentions per total talking time about each video). The y-axis shows the relative cumulated frequency of rates of speaking about the small triangle corresponding to the rate on the x-axis or a lower rate. The gray horizontal line represents the median indicating the central tendency

Discussion

Mutually exclusive activities compete for an organism's limited time. When PIEs or proxies of such events, correlate positively with an activity, this correlation can be viewed as selecting allocation of time to that activity. To speak is to behave (Skinner, 1957). Humans evolved largely living in groups. Groups with more effective communication are likely to have had a competitive advantage over groups with less effective communication (Tomasello, 2010). Thus, speaking might be an activity that is susceptible to PIEs or social PIE-proxies, including another person's feedback. If feedback functions as a social PIE-proxy selecting speaking about certain topics, indicated by use of certain nouns in conversations, we expect these nouns to occur more frequently when they are followed by feedback. In three of our four variations of the dependent variable, feedback appeared to increase occurrence of target words. When verbal feedback occurred contingent on speaking about the small triangle or the big triangle in the Heider and Simmel (1944) animation, these shapes were mentioned more frequently than when no feedback occurred. In Skinner's video, the box was mentioned more frequently when feedback for speaking about the box was given. The pigeon was mentioned less frequently in the condition were feedback occurred. All in all, the present results resemble those of Krasner's (1958) early review: effects of feedback on speech were small and occurred in three fourths of the examined manipulations.

The primary purpose in presenting the experiment here is to exemplify the effect of PIE-proxies on allocation of time to verbal activities. My choice of dependent variable avoided a range of problems that had occurred in previous experiments, including the pilot study. There was no ambiguity about whether the target behavior had occurred, and feedback could be provided reliably. Viewing the occurrence of the words "box/container/case/package," "pigeon/bird," and "triangle" as parts of talking about the topic "what the box, pigeon, or the triangles were doing" has high face validity. However, the experiment does not *demonstrate* ontogenetic selection. It cannot provide evidence for the function of PIE- proxies as selection events because no behavior change of participants as a function of "hmm" could become visible in group analysis. A

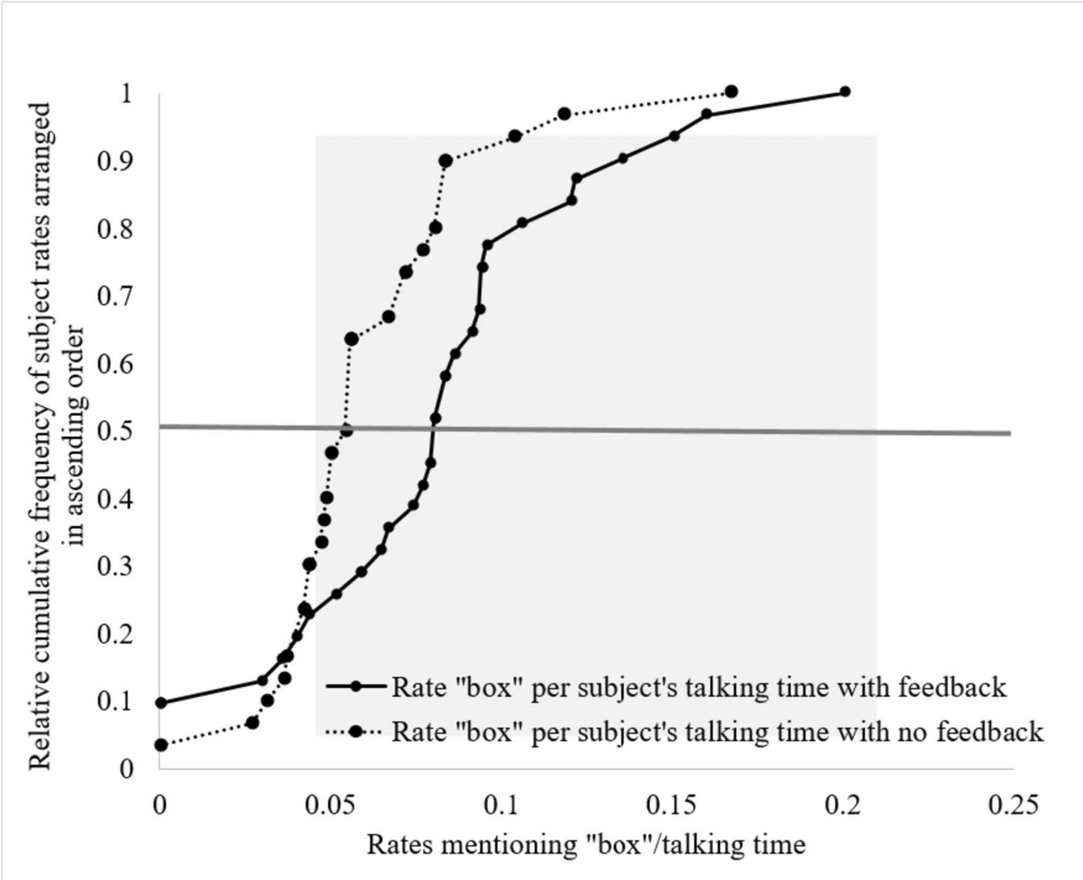

Fig. 3 Relative Cumulated Frequency of Rates of Speaking about the Box as a Function of Feedback Arranged in Ascending Order. The x-axis shows rates of speaking about the box (number of mentions per total talking time about each video). The y-axis shows the relative cumulated frequency of rates of speaking about the box corresponding to the rate on the x-axis or a lower rate. The gray horizontal line represents the median indicating the central tendency

within-subject comparison could have demonstrated an individual's *behavior change over time* that can more straightforwardly be interpreted as a result of a selection process. Nevertheless, it is probable that the group level differences in verbal behavior, which I observed in the feedback/no feedback condition, result from the same process, that is, selection.

My method of providing a link between the experiment and the conceptual framework was to relabel the behavioral process of unconditioned reinforcement[5] as selection by Phylogenetically Important Events (PIEs), and the process of conditioned reinforcement as selection by events that are proxies of PIEs. The PIE locution explicitly suggests a link between (1) (social) events contributing to survival in phylogeny (PIEs), and (2) differential responsiveness of conspecifics functioning as PIE—proxies for behavior during ontogeny. This link is adding a hypothesis to the conceptual literature on relations between ontogeny and phylogeny.

[5] See chapter 11 in Baum (2023) for an elaboration on the drawbacks of the concept of reinforcement.

Tonneau and Sokolowski (2000, p. 158) criticized over two decades ago that the selectionist analogy appears to have played a prominent role in behavior analysis, whereas a close reading of the literature revealed that, in fact, Skinner's proposal had not fostered any research program that could substantiate the analogy at a behavioral level. Since 2000, the idea of selection of the behavior of an individual has been developed further as explicated above (e.g. Baum, 2012), has led to computer models (McDowell, 2004), has been theoretically applied to verbal behavior (Simon, 2020), and has been modeled mathematically (Borgstede & Eggert, 2021). The present article is adding to this line of research by exemplifying how empirical verbal behavior data can be understood from that perspective. This consolidation of narrative builds a bridge between the two traditionally unconnected fields of study of *verbal behavior* (Skinner, 1957) and a *conceptual development of selection as a domain-general process* (Simon & Hessen, 2019). Of course, my data cannot provide a test of the adaptive relevance of topic choice in verbal interactions, but in the light of the ontogenetic

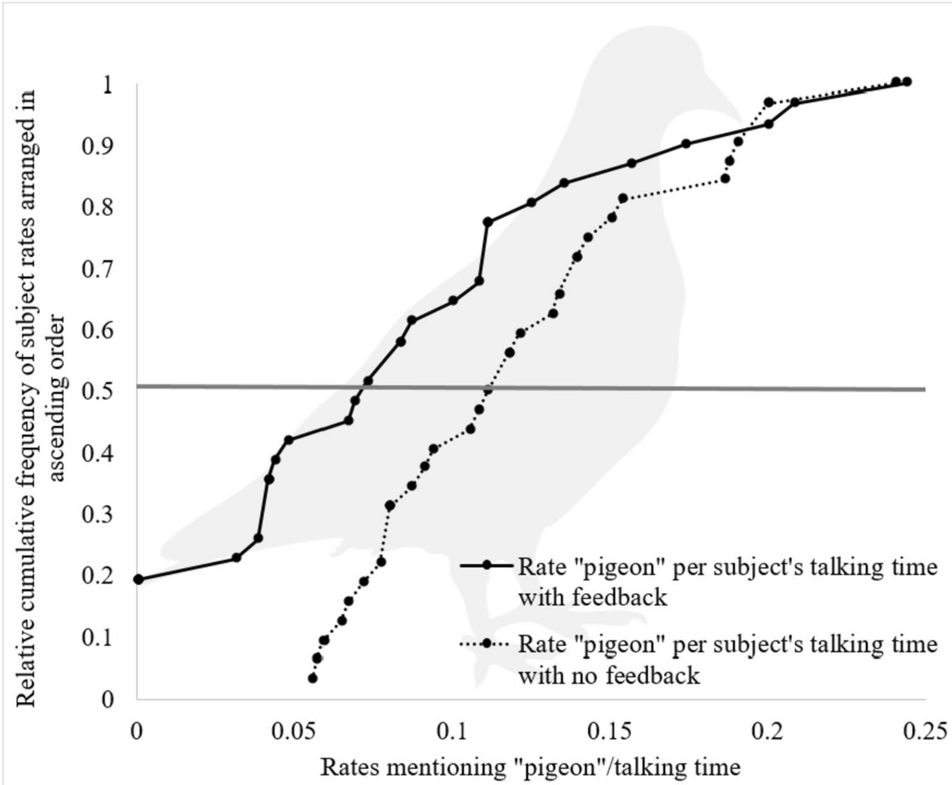

Fig. 4 Relative Cumulated Frequency of Rates of Speaking about the Pigeon as a Function of Feedback Arranged in Ascending Order. The x-axis shows rates of speaking about the pigeon (number of mentions per total talking time about each video). The y-axis shows the relative cumulated frequency of rates of speaking about the pigeon corresponding to the rate on the x-axis or a lower rate. The gray horizontal line represents the median indicating the central tendency

selection processes outlined in the introduction, a connection between topic choice and fitness on average and in the long run appears to be a likely story. By focusing on the collaboration between two approaches I hope that this story will contribute to building a naturalistic, monistic account of human verbal interchanges.

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Declarations

Conflicts of Interest The author does not have any conflicts of interest.

Ethical Approval All procedures performed were in accordance with the ethical standards of the Norwegian research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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