The Effects of Parametrically Manipulating the Ratio of Complimentary to Constructive Feedback Statements on Performance

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THE EFFECTS OF PARAMETRICALLY MANIPULATING THE
RATIO OF COMPLIMENTARY TO CONSTRUCTIVE FEEDBACK STATEMENTS
ON PERFORMANCE

by

AMANDA MENTZER

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

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The Effects of Parametrically Manipulating the Ratio of Complimentary to Constructive Feedback Statements on Performance

by

Amanda Mentzer

This manuscript has been read and accepted for the Graduate Faculty in Psychology to satisfy the dissertation requirement for the degree of Doctor of Philosophy.

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Abstract

THE EFFECTS OF PARAMETRICALLY MANIPULATING THE RATIO OF COMPLIMENTARY TO CONSTRUCTIVE FEEDBACK STATEMENTS ON PERFORMANCE

by

Amanda Mentzer

Advisor: Alicia M. Alvero

Performance feedback is frequently discussed and implemented. Although shown to be quite effective, the characteristics of feedback have yet to be fully explored. Feedback ratio was explored in this study. While participants evaluated the postural safety of body positions presented on a computer screen, researchers measured the (a) number of s that it took participants to evaluate body positions (i.e., response time), (b) percent of correctly evaluated body positions (i.e., percent correct), and (c) extent to which participants appreciated the statements they received after responding (i.e., rating). Using a mixed-factorial design, researchers manipulated feedback within groups and feedback ratio between groups. Within groups, all participants were exposed to a control session, in which responses produced confirmation statements, and subsequent experimental sessions, in which responses produced feedback statements. Between groups, participants were randomly assigned to one of the five following ratios of complimentary to constructive feedback statements: 10:0, 8:2, 5:5, 2:8, and 0:10. Feedback decreased response time and increased percent correct across all groups. Feedback ratio differentially affected most groups on response time and some groups on percent
correct. Both effects were more evident on response time than percent correct. Further, higher ratios of complimentary feedback statements were more effective on response time, while higher ratios of constructive feedback statements were more effective on percent correct. These results suggest that the effect of feedback ratio depends on the type of behavior targeted for improvement and that certain ratios may be more effective at changing behavior than others.
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**Introduction**

Feedback is used in basic and applied research, yet there is no universally accepted definition for it. Nonetheless, defining feedback is necessary to pursue its experimental analysis. To provide a comprehensive foundation upon which to investigate feedback, an experimental and applied definition are as follows, respectively: “presentation of an exteroceptive stimulus whose parameters vary as a function of parameters of antecedent responding,” (Mangiapanello & Hemmes, 2015, p. 54) and “information about performance that allows a person to change his/her behavior” (Daniels & Bailey, 2015, p. 157). The experimental definition specifies three components: (a) a stimulus, (b) an operant behavior, and (c) a relation between the stimulus and behavior. The applied definition translates experimental jargon and specifies those same components in practical environments: (a) information, (b) performance, and (c) a relation between information and performance.

Examples of feedback being used as a behavior change tactic include: safe driving of short-haul truck drivers on routes near their terminals (Hickman & Gellar, 2005); efficiency with which auto parts were replenished by stockers at a distribution facility (Goomas & Ludwig, 2007); safety behavior of a roofing crew at a building on a university campus (Austin, Kessler, Riccobono, & Bailey, 1996); and correct performance by undergraduate students during a computer task in a laboratory on a university campus (Bucklin, McGee, & Dickinson, 2003).

Feedback is important; a point reflected by the frequency with which, and the number of decades that, it has been discussed and implemented. From 1983 to 2013, the word feedback appears in the title of 441 journal articles, across 50 behavioral journals (i.e., journal titles that include the word behavior) in which humans were participants (Mangiapanello & Hemmes, 2015). Using the publication history of the *Journal of Organizational Behavior Management*...
(JOBM), researchers assessed the frequency with which feedback has been used to improve performance. From 1977 to 2009, results from three consecutive review papers published in JOBM found that feedback was the most frequently implemented behavior change tactic (Balcazar, Shupert, Daniels, Mawhinney, & Hopkins, 1989; Nolan, Jarema & Austin, 1999; VanStelle et al., 2012). Various explanations have been proposed to account for its frequent implementation. Prue and Fairbank (1981) indicated that using feedback is inexpensive, requires low response effort, can be used in environments with limited resources, can decrease the use of aversive procedures, and has practical utility. That is, feedback can be implemented on any behavior, of any individual or group, and in any environment.

For as long as feedback has been discussed and implemented, researchers have experimentally investigated its effects. From 1975 to 1998, two consecutive review papers published in JOBM identified applied studies in which feedback was implemented in organizations in the following four journals: Academy of Management Journal (AMJ), Journal of Applied Behavior Analysis (JABA), Journal of Applied Psychology (JAP), and JOBM (Alvero, Bucklin, & Austin, 2001; Balcazar, Hopkins, & Suarez, 1985). Overall, these reviews found that 43.30% of feedback interventions produced consistent effects (i.e., desired performance improvements across all participants, environments, and behaviors) and 42.27% produced mixed effects (i.e., desired performance improvements across some, but not all, participants, environments, and behaviors).

Replicating the procedure of the aforementioned reviews, Mentzer, Hagigat, and Alvero (2013) assessed the effectiveness of feedback interventions from 1999 until 2011. In their unpublished review paper, Mentzer et al. found that 38.07% of feedback interventions produced consistent effects and 42.05% of produced mixed effects, thus supporting and extending previous
findings. To summarize over three decades of research across four journals, researchers repeatedly have found that approximately 40% of feedback interventions produce consistent effects and approximately 80% produce consistent or mixed effects.

In addition to analyzing the effects of feedback, behavior analytic research seeks to elucidate the mechanisms accounting for those effects to determine the function feedback serves. Although research suggests that feedback serves many or multiple functions, discussions regarding the behavioral principles underlying those effects are limited (Duncan & Bruwelheide, 1985; Mangiapanello & Hemmes, 2015; Peterson, 1982). Mangiapanello and Hemmes provide a behavior analytic interpretation of feedback and conclude that “feedback phenomena are reducible to operant conditioning” (p. 69). Discussing feedback in terms of an operant conditioning procedure offers a more parsimonious means for its technological and analytic advancement than entertaining previous notions that feedback is a physical stimulus, class of stimuli, or principle of behavior.

Feedback is comprised of an undefined, and likely infinite number of, characteristics; however, there is neither a universally accepted term, nor a definition, for these characteristics. To clarify, implementing feedback involves determining how often it is delivered (i.e., frequency), the type of information it provides (i.e., content), whose performance it describes (i.e., participants), and who or what provides it (i.e., source). Frequency, content, participants, and source exemplify some of the characteristics of feedback. Given that the integrity with which feedback is implemented improves by identifying and describing its characteristics, the behavioral community may benefit from agreeing on a term for and defining feedback characteristics. A proposed definition for feedback characteristics is as follows: permanent and inseparable features of an exteroceptive stimulus (i.e., information), or the relation between that
stimulus and an operant behavior (i.e., performance), that comprise a feedback procedure and are
distinguishable based on physical or temporal dimensions. With operational definitions for
feedback and feedback characteristics, researchers are better positioned to conduct experiments
that are of value to practitioners and researchers alike.

To organize feedback characteristics, researchers have recommended the development of
a classification system, and some of them have proposed a function-based classification system
(e.g., Alvero et al., 2001; Duncan & Bruwelheide, 1985; Ford, 1980). Despite these
recommendations, a classification system has yet to be proposed, and the proportion of feedback
applications in which researchers have not reported a characteristic used in their procedure has
increased across time. For example, feedback frequency was not reported in 1.75% of the
applications reviewed by Balcazar et al. and 9.38% of those reviewed by Alvero et al. Although
evidence supports the need for a system to classify feedback characteristics, it is possible to
conduct sound experimental analyses of individual characteristics independent of such a system.

Feedback ratio is a characteristic that has received little, if any, attention in the behavioral
literature. In addition to proposing the term, following is a definition for feedback ratio: a
proportional relation between two, or more, classes of feedback. Operationalizing feedback
requires describing each class of feedback and identifying their proportional relation. Consider
the following example: When an employee engages in a response, feedback can be delivered
contingent on responding correctly (e.g., complimentary feedback) or incorrectly (e.g.,
constructive feedback). Complimentary and constructive feedback statements represent two
different classes of feedback, and each class provides “information about performance that
allows a person to change his/her behavior” (Daniels & Bailey, 2015, p. 157).
Because researchers do not always distinguish between feedback classes, or identify the proportional relation between them, it is plausible that feedback ratio varies unsystematically when feedback interventions are implemented in applied environments. Researchers in other paradigms within psychology have distinguished between feedback classes, investigated their proportional relation, and found reliable correlations between the ratio of different classes and various behavioral measures (e.g., Beaman & Wheldall, 2000; Gottman, 1994; Losada & Heaphy, 2004). As such, there may be value in researching the effects of feedback ratio in the field of organizational behavior management (OBM).

Before reviewing correlational studies that motivate the experimental investigation of feedback ratio, two points should be considered. First, developing a classification system and analyzing the effects of feedback characteristics should be accomplished independently. Both objectives are important to understanding feedback. Identifying and describing relevant feedback characteristics permits the development of a classification system. As an antecedent, the information about performance may serve a discriminative or motivating function, and as a consequence, it may serve a reinforcing or punishing function. Given that function can vary, analyzing the effects of feedback characteristics should be independent of their classification into a comprehensive system. Second, “feedback is the name of an operant conditioning procedure,” (Mangiapanello & Hemmes, 2015, p. 70). Conceptualizing feedback as a physical stimulus, which tends to be how researchers in OBM have pursued its analysis, is limiting because it does not account for the operant behavior (i.e., performance) or the relation between the exteroceptive stimulus (i.e., information) and the operant behavior (i.e., performance). Given that feedback has the capacity to serve various functions (e.g., discriminative, reinforcing, or punishing), serve multiple functions, or change its function across time, considering feedback a behavioral
principle is incorrect (Peterson, 1982). Therefore, conceptualizing feedback as an operant procedure that involves a stimulus, an operant behavior, and a relation between them may advance the extent to which feedback ratio is operationalized.

The most effective feedback ratio for improving performance has not been determined experimentally. While correlations between ratios and behavioral measures have not yet been investigated in OBM, research in other areas of psychology suggests that higher ratios of positive to negative, or approving to disapproving, statements produce more beneficial outcomes than lower ratios of such statements.

In counseling psychology with married couples, Gottman (1994) used an observational coding system to score the number of positive and negative interactions that occurred during a conflict. After classifying couples into stable or unstable marriages, Gottman found that stable marriages produced a mean positive to negative ratio of 5.10 for husbands and 5.06 for wives, and unstable marriages produced a ratio of 1.06 for husbands and 0.67 for wives. With statistically significant differences across marriage type (i.e., stable versus unstable marriages), and no statistically significant differences between husbands and wives within either type of marriage, Gottman proposed that there was a “rough universal constant”: During the resolution of conflicts, stable married couples engage in a ratio of 5 positive interactions to 1 negative interaction (p. 183).

In seven longitudinal studies using over 400 couples, Gottman and his colleagues reported similar findings, refined their observational coding system, and developed prediction models (i.e., Buehlman, Gottman, & Katz, 1992; Gottman & Levenson, 2002; Gottman, Coan, Carrère, & Swanson, 1998; Carrère, Buehlman, Gottman, Coan, & Ruckstuhl, 2000; Gottman, 1991; Gottman & Krokoff, 1989; Carrère & Gottman, 1999). By calculating the ratio of positive
to negative affect during conflicts, Gottman et al. (1998) could not only predict whether couples would divorce with 83% accuracy, but they could predict whether stable couples were satisfied with 80% accuracy.

Similar findings have been reported in educational psychology. After analyzing 30 years of research on teachers’ approval and disapproval of student behavior in classrooms across the world, Beaman and Wheldall (2000) found that teachers’ approval was positively correlated with students’ on-task behavior; teachers’ disapproval was negatively correlated with students’ on-task behavior; and teachers deliver disapproval with a greater frequency than they deliver approval. Similarly, after measuring the number of approving and disapproving statements made by teachers, Madsen and Madsen (1974) found that students in classrooms where teachers delivered at least a 4:1 ratio of approving to disapproving statements engaged in more appropriate classroom behavior and performed better academically than students in classrooms where teachers delivered lower ratios of approval to disapproval.

In organizational psychology, Losada (1999) used behavioral measures and assessments to classify business teams into high, medium, and low performance teams. After coding the number of positive and negative verbal statements made during strategic planning sessions, Losada found that ratio was correlated with performance such that high positive to negative ratios occurred in high performing teams and low ratios occurred in low performing teams. Losada and Heaphy (2004) extended Losada’s earlier findings by calculating the precise ratios of positive to negative statements for each team and found that the ratio of positive to negative verbal statements for high-performing teams was 5.61, medium-performing teams was 1.86, and low-performing teams was .36. Losada and Heaphy concluded that knowing only the ratio of positive to negative verbal statements for a business team predicts performance.
Finding relations between the ratio of different feedback classes and behavioral measures in counseling, educational, and organizational psychology support pursuing the experimental analysis of feedback ratio in OBM. As such, the purposes of this study were to assess the effects of feedback and feedback ratio on performance. In a laboratory setting using undergraduate students engaged in a computer task, researchers employed a mixed-factorial design in which feedback was manipulated within groups and feedback ratio was manipulated between groups.

**Method**

**Participants**

Recruited from advertisements and an introductory psychology subject pool, 108 self-selected undergraduate students participated in this study. Compensation consisted of experiencing the role of serving as a participant and earning research credits for an introductory psychology course in exchange for serving as a participant. Inclusion criteria required participants to be fluent in English and at least 18-years old. All procedures complied with ethical and safety guidelines set forth by the City University of New York (CUNY) Human Research Protections Program (HRPP), American Psychological Association (APA), and Behavior Analyst Certification Board (BACB).

**Setting**

Researchers conducted this study in a laboratory at a university in the northeastern United States that provides certificates and degrees for continuing, undergraduate, and graduate education (see Appendix A for a scaled diagram of the laboratory). Researchers used one public area (i.e., Main Room 1) and three private areas (i.e., Main Room 2, Room D and Room E). The public area was accessible to individuals unrelated the study (e.g., laboratory members or
individuals meeting with laboratory members), and the private areas were accessible to researchers and participants.

Main Room 1 contained a Break Area and two workstations. The Break Area included a large table (i.e., two rectangular tables pushed side-by-side, such that the longer sides of the tables were touching) surrounded by five chairs, and it was positioned in the middle of the room. Workstations included a computer, table, and chair, and they were positioned along the walls of rooms. Main Room 2 included two workstations, Room D included a table and chairs, and Room E included a workstation.

**Materials**

In addition to standard laboratory chairs and tables, researchers used the following materials: (a) a Sony Handycam HDR-CX150 Camcorder, a high definition camcorder that captured pictures; (b) a Dell computer that operated on Windows 7; (c) a Hewlett-Packard computer operating on Windows 8; (d) Microsoft® Word, a word processor; and (e) Microsoft® Visual Basic 2008 Express Edition, a programming language and integrated development environment (i.e., IDE).

Researchers used Microsoft® Word to make the following documents: (f) the Procedural Script, a task analysis that pinpointed the behaviors necessary to run participants; (g) Informed Consent, an ethics document that provided regulated information pertaining to the ethics of conducting this study (see Appendix B); (h) the Postural Safety Information Sheet, an instructional document that provided information regarding how to sit safely according to the good working positions of the U.S. Occupational Safety and Health Administration (2008; see Appendix C); (i) the Participant Survey, an appraisal document with questions relating to social
validity (see Appendix D); and (j) the Participant Survey Information Sheet, an auxiliary
document for the Participant Survey (see Appendix E).

A laboratory technician used Microsoft® Visual Basic 2008 Express Edition to write a
computer program that used pictures captured from the SONY Handycam and exported data into
Comma Separated Value (i.e., CSV) files.

To store, analyze, and graph data, researchers used (k) Microsoft® Excel, a spreadsheet
application that read CSV files; (l) RStudio, a free and open source IDE for R; and (m) R, a
programming language and software environment for computing statistics and creating graphic.

**Independent Variables and Levels**

Feedback was manipulated within groups. All participants were exposed to confirmation
statements during control sessions and feedback statements during experimental sessions.
Confirmation statements were details confirming that performance was evaluated and
instructions to continue evaluating performance. For example, a confirmation statement
indicated, “A body position was EVALUATED. CONTINUE your EVALUATIONS by
referring to the Postural Safety Information Sheet”. Feedback statements were details about the
correctness of performance and how to maintain correct or improve incorrect performance.

Feedback ratio was manipulated between groups. Participants were exposed to one of the
five following ratios of complimentary to constructive feedback statements: 10:0, 8:2, 5:5, 2:8,
and 0:10. Complimentary feedback statements were details about correct performance and how
to maintain it, and constructive feedback statements were details about incorrect performance
and how to improve it. For example, a complimentary feedback statement may have indicated,
“Yes, the NECK body position was UNSAFE. MAINTAIN your CORRECT performance by
referring to the Postural Safety Information Sheet,” whereas a constructive feedback statement
may have indicated, “No, the KNEE body position was SAFE. IMPROVE your INCORRECT performance by referring to the Postural Safety Information Sheet”.

**Dependent Measures**

- **Response time.** Researchers (a) measured the number of s between the start of a trial and the participant clicking a response option (i.e., neck, elbow, knee, or ankle) per trial per participant; (b) calculated mean response time per session per participant; and (c) calculated mean response time per session per group.

- **Percent correct.** Researchers (a) measured the correctness of evaluating the safety of a body position per trial per participant; (b) calculated percent correct per session per participant; and (c) calculated mean percent correct per session per group.

- **Rating.** At the end of each session, participants rated the extent to which they appreciated the statements that they received after their responses. Researchers (a) measured rating per session per participant and (b) calculated mean rating per session per group.

**Reliability and Integrity Measures**

- **Reliability of pictorial stimuli.** Two independent observers evaluated the extent to which four body positions depicted in pictorial stimuli were safe or unsafe. A researcher assessed the reliability of their evaluations by calculating trial-by-trial inter-observer agreement (IOA), included pictorial stimuli for which IOA was 100% (i.e., observers agreed on the safety of all four body positions depicted in the pictorial stimulus), and excluded pictorial stimuli for which IOA was less than 100% (i.e., observers disagreed on the safety of at least one of the four body positions depicted in the pictorial stimulus). Observers reevaluated excluded pictorial stimuli, and the researcher recalculated IOA. Again, pictorial stimuli with an IOA of 100% were
included, and pictorial stimuli with an IOA less than 100% were excluded. As such, only pictorial stimuli for which IOA was 100% were included in this study.

**Reliability of dependent measures.** Data for participant performance were collected electronically; thus, calculating IOA for the dependent measures was unwarranted.

**Treatment integrity.** The computer program delivered confirmation, complimentary feedback, and constructive feedback statements; thus, calculating treatment integrity for the independent variables was unwarranted.

**Experimental Design**

Researchers employed a mixed-factorial design to assess the effects of feedback and feedback ratio on performance (see Figure 1 for a layout of the experimental design). Feedback was manipulated within groups, and feedback ratio was manipulated between groups. The first session for all participants was a control session in which confirmation statements (i.e., no feedback) were delivered. Before the second session, participants were randomly assigned to one of the following five ratios of complimentary to constructive feedback statements: 10:0, 8:2, 5:5, 2:8, and 0:10. Researchers used randomized blocks of five to assign participants to experimental groups based on the chronological order in which they arrived to participate in this study. Remaining sessions were experimental such that feedback statements were delivered.

**Pre-Experimental Procedure**

Upon arrival to the laboratory, participants were escorted to (a) the Break Area of Main Room 1, where they put their personal belongings, (b) Room D, where they were presented with the Consent Form and the Postural Safety Information Sheet, (c) Room E, where they were exposed to practice trials, and (d) the Break Area, where they took a break before being exposed to experimental procedures (see Figure 2 for a flowchart of procedures).
Consent form. After participants were seated in Room D, researchers (a) provided the consent form, (b) gave them time to read it, privately, (c) provided an opportunity to ask questions, (d) answered questions, and (e) collected the signed consent form. All participants provided informed consent.

Postural safety information sheet. After participants provided consent, researchers (a) provided the Postural Safety Information Sheet, (b) give them time to read it, privately, (c) provided an opportunity to ask questions, (d) answered questions, and (e) escorted participants to Room E, where they sat on a chair at a computer workstation.

Practice trials. After participants were seated in Room E, researchers (a) summarized the experimental procedure, (b) addressed important aspects of a session, (c) exposed participants to one trial and one intertrial interval, while addressing important aspects of each, (d) instructed participants to enter the Main Room when a rating screen appeared on the monitor, (e) gave them time to complete 7 trials, privately, (f) addressed how to rate their appreciation for statements, and (g) escorted them to the Break Area for their first break.

Experimental Procedure

Across sessions. At the start of sessions, participants were escorted from the Break Area to Room E, where researchers instructed them to sit on the chair and attend to the monitor. When participants were seated and attending, researchers (a) reminded participants to focus on three critical aspects of the experimental procedure, (b) instructed them to enter Main Room 1 after they rated their appreciation for statements, and (c) exited Room E.

Control session. The first session for all participants was a control session (i.e., confirmation statements). If they performed below 30% or above 70% correct, they were excluded from the study and debriefed by researchers (q.v., Method, Post-experimental
Procedure, Debriefing). If participants performed between 30% and 70% correct, they were exposed to an experimental session.

*Experimental sessions.* Participants were exposed to experimental sessions (i.e. a ratio of complimentary to constructive feedback statements; e.g., 10:0, 8:2, 5:5, 2:8, or 0:10) until they (a) performed below 20% or above 80% correct during a session or (b) completed six experimental sessions. Exclusion criteria were established for experimental sessions because delivering feedback statements was contingent on performance for 10 of the 48 trials. Delivering complimentary and constructive feedback statements with integrity each session required participants to respond at least 20% correct (i.e., group B [10:0]) and at most 80% correct (i.e., group F [0:10]), respectively.

At the end of sessions, participants were escorted to the Break Area, where researchers instructed them to sit on the chair and take a break. When participants were seated, researchers (a) prepared the next session in Room E, (b) returned to the Break Area, and (c) escorted participants back to Room E for their next session. When participation was complete, researchers escorted participants to Room D for post-experimental procedures (q.v., Method, Post-experimental Procedure).

*Within sessions.* During sessions, participants were exposed to a session-start screen, 48 trials followed by 3.5 s intertrial intervals, a rating screen, and a session-end screen. When participants double-clicked on the session-start screen, the computer program recorded the session-start time.

*Within trials and intertrial intervals.* During trials, participants experienced a pictorial stimulus, an instruction, and four response options across the bottom of the screen (see Appendix F for a trial screenshot). Participants (a) read the instruction, (b) assessed the safety of body
positions in the pictorial stimulus, and (c) clicked on the response option that corresponded with their evaluation. The computer program recorded (a) the pictorial stimulus presented, (b) the response option selected, (c) correctness, and (d) response time. After participants clicked a response option, they were exposed to an intertrial interval.

During intertrial intervals, participants experienced a blank screen or one of three of the following statement types: confirmation, complimentary feedback, and constructive feedback. Responses made by participants during intertrial intervals had no effect on the duration of the intertrial interval. The computer program recorded the type of intertrial interval.

Across trials and intertrial intervals. Across trials, participants were presented with the following eight types of pictorial stimuli: neck safe, neck unsafe, elbow safe, elbow unsafe, knee safe, knee unsafe, ankle safe, and ankle unsafe. In blocks of eight without replacement, participants were randomly presented with an equal number of each stimulus type. The following two instructions were used: “Identify the body position that is SAFE” and “Identify the body position that is UNSAFE”. Participants were randomly presented with 24 trials of each instruction. The following four response options were presented from left to right: neck, elbow, knee, and ankle.

Across intertrial intervals, participants experienced 38 (i.e., 79.2%) blank screens and 10 (i.e., 20.8%) statements. During control sessions, responses produced confirmation statements, randomly. During experimental sessions, responses produced feedback statements based on the group to which participants were randomly assigned and their performance. To clarify, when participants who were in experimental groups that included complimentary feedback statements responded correctly, complimentary feedback statements were delivered. Similarly, when participants who were in experimental groups that included constructive feedback statements...
responded incorrectly, constructive feedback statements were delivered. After the allocated number of complimentary and constructive feedback statements were delivered, responses produced a blank screen for the remaining intertrial intervals during the session.

Rating. After the last intertrial interval, a rating screen was presented in which participants were to rate the extent to which they appreciated the statements they received after responding (see Appendix G for a screenshot of the rating screen). Participants clicked and dragged a marker to the number that reflected their degree of appreciation, based on the following scale: -100 (i.e., extremely unappreciative) to 100 (i.e., extremely appreciative), and clicked OK. Participants were exposed to a session-end screen, and the computer program recorded the (a) percent of correctly evaluated trials, (b) rating, and (c) session result (i.e., below inclusion criteria, within inclusion criteria, or above inclusion criteria).

Post-Experimental Procedure

Participants were exposed to the Participant Survey and debriefing in Room D. After participants completed the Participant Survey and received debriefing, researchers escorted participants to the Break Area to collect their belongings and to the main door to exit the laboratory.

Participant survey. After participants were seated in Room D, researchers (a) provided participants with the Participant Survey, (b) described the survey, (c) answered questions, and (d) provided participants with as much time as they need to complete the survey.

Debriefing. After collecting the Participant Survey, researchers (a) thanked participants for their involvement in the study, (b) provided a general explanation of the purpose of the study, and (d) explained how information regarding the specific purposes of the study could be provided after all data were collected.
Data Analyses

**Outlier removal.** Post hoc review of the distribution of response times revealed a significant percentage of outliers, both as very immediate and very protracted responses. Although no limits on response times were established before conducting this study, trials with response times less than 2 s or longer than 25 s were considered error trials. The following criteria were applied to omit these trials from data analysis: (a) all data from participants whose response times were less than 2 s or longer than 25 s for more than 20% of their trails and (b) all trial data from remaining participants for whom response times were less than 2 s or longer than 25 s.

**Data imputation.** Experimental sessions ended when performance was less than 20% correct, or more than 80% correct (q.v., Method, Experimental Procedure, Across sessions.). Because these performance limits were established, some participants completed fewer than 6 experimental sessions. To include data from those participants and permit proper statistical analyses, data were imputed (i.e., replacing missing data with duplicate data).

**Results of outlier removal and data imputation.** To ensure that data were of high quality before conducting statistical analyses, outlier data were removed and missing data were imputed. Starting with data for 96 participants who had completed 31,200 trials, outlier criteria resulted in removing data for 6 participants (i.e., 1968 trials; 6.3% of the dataset) and 1560 trials from the remaining participants (i.e., 5% of the dataset). Imputation criteria resulted in duplicating data for 10 participants, all who performed above 80% correct during their final experimental session. Until the session in which duplication was applied, all participants showed an increasing trend in percent correct, and 8 of 10 participants showed a decreasing trend in response time. Given these trends, data from their last experimental session were duplicated to
ensure that all participants had data for 6 experimental sessions. With 12 participants excluded for performing above or below the inclusion criteria during the control session, and 6 participants excluded because of outlier criteria, data represent 90 participants and 27,672 trials.

**Analyses.** Within groups, the effects of feedback were analyzed visually and statistically. Using visual analyses, feedback effects were assessed by calculating changes in performance between control and experimental sessions. Immediate, overall, and delayed changes in performance were analyzed by calculating performance differences between session 1 and 2, control and experimental sessions, and session 1 and 7, respectively. To clarify, calculating immediate and delayed performance changes included data from two sessions (i.e., 1 and 2 or 1 and 7), and calculating overall performance changes included data from all sessions. First, performance during all experimental sessions (i.e., sessions 2-7) was averaged, and then, the difference between control and experimental sessions was calculated.

Using statistical analyses, the effects of feedback were assessed using separate, one-way repeated measures ANOVAs, with session as the repeated-measures factor, to compare performance changes across sessions for each group. Planned multiple comparisons with Bonferroni adjusted $p$ values were used to determine what sessions were significantly different from other sessions.

Between groups, the effects of feedback ratio were assessed by comparing the first experimental session in which feedback effects were observed in one group with that of all other groups.
Results

Effects of Feedback

Feedback improved performance for all groups on all measures, except on some measures of percent correct for group E. Table 1 provides descriptive statistics for all groups on all measures during all sessions, and respectively, Figures 3, 4, and 5 display mean response time, mean percent correct, and mean rating for all groups across sessions. For all groups, feedback showed immediate mean response time decreases (i.e., comparing performance during session 2 with that from session 1), that overall mean response time during experimental sessions was faster than mean response time during control sessions (i.e., comparing average performance during experimental sessions with that from session 1), and decreasing trends on mean response time and its variability across sessions (see Table 1 and Figure 3). Table 2 provides a summary of the immediate, overall, and delayed changes in performance between control and experimental sessions. Feedback produced the most immediate and greatest overall changes on response time for group C (i.e., 8:2), and the most delayed changes were observed for group B (i.e., 10:0).

Separate, one-way repeated measures ANOVAs revealed significant session (i.e., feedback) effects on mean response time for all groups: group B (i.e., 10:0), $F(6, 108) = 12.448, p < .001$, group C (i.e., 8:2), $F(6, 108) = 11.704, p < .001$, group D (i.e., 5:5), $F(6, 108) = 15.928, p < .001$, group E (i.e., 2:8), $F(6, 90) = 5.308, p < .001$, and group F (i.e., 0:10), $F(6, 102) = 5.569, p < .001$. Figure 6 shows the results of planned comparisons for all groups and measures.

For all groups, except group E (i.e., 2:8), feedback showed immediate mean percent correct increases and that overall mean percent correct during experimental sessions was higher than mean percent correct during control sessions. For all groups, feedback showed increasing trends on mean percent correct, and its variability, across sessions (see Table 1 and Figure 4).
Feedback produced the most immediate, greatest overall, and most delayed changes on percent correct for groups F (i.e., 0:10), D (i.e., 5:5), and C (i.e., 8:2), respectively (see Table 2).

Separate, one-way repeated measures ANOVAs revealed significant session (i.e., feedback) effects on mean percent correct for three groups: group C (i.e., 8:2), $F(6, 108) = 5.281$, $p < .001$, group D (i.e., 5:5), $F(6, 108) = 4.032$, $p = .001$, and group F (i.e., 0:10), $F(6, 102) = 4.966$, $p < .001$ (see Figure 6 for the results of planned comparisons).

Feedback effects for all groups showed immediate mean rating increases, that overall mean rating during experimental sessions was higher than mean rating during control sessions, and decreasing trends on mean rating across sessions (see Table 1 and Figure 5). Feedback produced the most immediate, greatest overall, and most delayed changes on mean rating for group D (i.e., 5:5) (see Table 2). Effects on mean rating were found for one group: group D (i.e., 5:5), $F(6, 108) = 2.758$, $p = .016$; however, planned comparisons revealed that rating did not significantly differ between any sessions.

Effects of Feedback Ratio

Feedback ratio differentially affected response time for most groups, percent correct for some groups, and rating for zero groups. Figure 6 provides an overview of the session effects on mean response time, mean percent correct, and mean rating. Feedback effects on mean response time occurred during the first experimental session (i.e., session 2) for group C (i.e., 8:2), the fourth experimental session (i.e., session 5) for groups B (i.e., 10:0) and D (i.e., 5:5), the fifth experimental session (i.e., session 6) for group E (i.e., 2:8), and the last experimental session (i.e., session 7) for group F (i.e., 10:0). Group C (i.e., 8:2) was the only group in which the control session (i.e., session 1) was significantly different from all experimental sessions (i.e., sessions 2-7). Groups C (i.e., 8:2), E (i.e., 2:8), and F (i.e., 0:10) had no experimental sessions.
that were significantly different from any other experimental session. Feedback effects on mean percent correct occurred during the second experimental session (i.e., session 3) for group F (i.e., 0:10) and the fourth experimental session for groups C (i.e., 8:2) and D (i.e., 5:5). Groups D (i.e., 5:5) and F (i.e., 0:10) had no experimental sessions that were significantly different from any other experimental sessions.

**Discussion**

**Effects of Feedback and Feedback Ratio**

Feedback and feedback ratio affected mean response time and mean percent correct. Feedback improved performance for all groups on mean response time and some groups on mean percent correct. Feedback effects on mean response time occurred during more sessions for groups with a higher, or an equal, ratio of complimentary to constructive feedback statements (i.e., groups B [10:0], C [8:2], and D [5:5]) than those with more constructive feedback statements (i.e., groups E [2:8] and F [0:10]). Feedback effects on mean percent correct occurred for groups C and D; however, they were most evident for the group exposed to only constructive feedback statements (i.e., group F).

Feedback ratio differentially affected performance for most groups on mean response and some groups on mean percent correct. Feedback effects occurred most immediately on mean response time for group C (i.e., 8:2); thus, the most effective feedback ratio for improving mean response time involved delivering both types of feedback and including more complimentary than constructive feedback statements. From group C, as the complementariness of the ratio increased (i.e., to 10:0 [group B]) or the constructiveness of the ratio increased (i.e., to 5:5 [group D] to 2:8 [group E] to 0:10 [group F]), the effects of feedback ratio on mean response time decreased systematically. Given that feedback effects were evident during the same session for
groups B and D, delivering all complimentary feedback statements had the same effect on mean response time as providing an equal ratio of complimentary to constructive feedback statements. Feedback effects occurred most immediately on mean percent correct for group F; thus, the most effective feedback ratio for improving mean percent correct involved delivering all constructive feedback statements. Given that feedback effects were evident during the same session for groups C and D, delivering both types of feedback and including more complimentary than constructive feedback statements had the same effect on mean percent correct as delivering both types of feedback and including an equal ratio of complimentary to constructive feedback statements.

Overall, the effects of feedback and feedback ratio were more apparent on mean response time than mean percent correct. Further, complimentary feedback statements improved mean response time more than mean percent correct, while constructive feedback statements improved mean percent correct more than complimentary feedback statements. A potential explanation for why improvements on each measure occurred as a result of different types of feedback can be explained behaviorally. Faster response times and increases in percent correct suggest that feedback statements may have accrued different conditioning properties. It is possible that complimentary and constructive feedback statements accrued reinforcing and aversive properties, respectively. As such, exposure to higher ratios of complimentary feedback statements may evoke responding, or approach behavior. By responding faster, there may be an increase in the probability of responding incorrectly. On the other hand, exposure to higher ratios of constructive feedback statements may abate responding, or avoidance behavior. By responding slower, there may be an increase in the probability of responding correctly. Although
this explanation is plausible given the findings, it is merely speculation given the preliminary nature of these data and the absence of a demonstrating a causal relation.

**Comparison with Previous Research**

When considering feedback effects, these findings are in accord with those of previous review papers published in *JOBM* indicating that the majority of feedback applications produce consistent or mixed effects (e.g., Alvero et al., 2001; Balcazar et al., 1985). Feedback produced consistent effects on mean response time and mixed effects on mean percent correct, while feedback ratio produced mixed effects on both measures.

When considering feedback ratio effects, some of these findings are aligned with previous correlational studies, while others contradict them. Previous research suggests that including both types of feedback statements, and having a higher ratio of complimentary to constructive, produces greater performance improvements. For example, Gottman and his colleagues (e.g., Gottman, 1994; Gottman et al., 1998) reported that higher ratios of positive to negative interactions (i.e., 5:1) during conflicts correlate with marital stability and satisfaction. Similarly, Losada and his colleagues (e.g., Losada, 1999; Losada & Heaphy, 2004) found that higher ratios of positive to negative verbal statements (i.e., 5.61:1) during business meetings correlate with high performance. As such, the effects of feedback and feedback ratio on response time in this study are as predicted by the correlational research discussed. Their effects on percent correct, on the other hand, contradict those findings, given that the greatest improvements occurred for participants who were exposed to only constructive feedback statements.

Two prevailing similarities between these and previous findings are the varied effects of feedback and that a more comprehensive characterization of feedback is necessary to advance its
understanding. Like the majority of feedback applications reviewed by Balcazar et al. (1985) and Alvero et al. (2001), feedback had consistent and mixed effects. Without a universal operational definition for feedback, new ones are consistently proposed. Without agreeing on a term for its characteristics, synonyms are used (e.g., dimensions or parameters). Without identifying and defining all relevant feedback characteristics, technological descriptions are absent. When definitions for feedback, and terms for feedback characteristics, vary across publications, and there is no comprehensive classification system, it is not surprising that criticisms are repeatedly made about the ambiguities surrounding feedback (e.g., Duncan & Bruwelheide, 1985; Ford, 1980; Houmanfar, 2013; Mangiapanello & Hemmes, 2015; Peterson, 1982).

Previous research suggests that a classification system should be based on the function feedback serves (e.g., Alvero, et al., 2001; Duncan & Bruwelheide, 1985); however, this research differs from previous research by proposing the development of a structural classification system. Although it is more appropriate to formally propose a structural classification elsewhere, suggestions for, and the benefits of, its development are reviewed. Arguably the most complicated aspect of understanding feedback relates to its characteristics. Feedback characteristics have been proposed randomly (Ford, 1980), systematically in unclearly described categories (Duncan & Bruwelheide, 1985; Prue & Fairbank, 1981), and based on categories proposed by others (Alvero et al., 2001; Balcazar et. al., 1985). As such, proposing a structural classification system for organizing feedback characteristics may involve determining to which of the three feedback components a characteristic applies. To reiterate, feedback is comprised of the following components: (a) an exteroceptive stimulus (i.e., information), (b) an operant behavior (i.e., performance), and (c) a relation between the stimulus and behavior. Feedback characteristics involving the exteroceptive stimulus may include participants (i.e., whose
performance is described; e.g., individual or group), medium (i.e., means used to communicate the information; e.g., written or graphic), or duration (i.e., amount of time the information is provided). Aspects of the relation may include characteristics such as contiguity (i.e., the amount of time between behavior and information or information and behavior) or contingency (i.e., probability of information given behavior).

**Contribution to Feedback Literature**

These findings contribute to behavioral literature discussing feedback by highlighting feedback ratio, demonstrating differential effects, suggesting that effectiveness may be relative, and proposing a classification system. Feedback ratio has been excluded from seminal reviews proposing feedback characteristics. These preliminary data suggest that feedback ratio is a characteristic worth considering when implementing feedback. They also imply that other, possibly more relevant, feedback characteristics may have yet to be considered. These data also contribute by demonstrating the differential effects of feedback ratio and finding that the most effective feedback ratio relates to the behavior measured. At this point, differential effects may be unexpected because different classes of feedback, or the proportional relation between them, are rarely, if ever, discussed. When the discussion of different feedback classes occurs in the literature, understanding that parametrically manipulating the ratio may produce differential effects, and the most effective ratio may relate to the behavior measured will be of value. Another contribution of this study involves the proposal of a classification system based on structure.

These findings also extend the behavioral literature surrounding feedback by experimentally investigating feedback ratio and discussing feedback as an operant procedure. Until this study, only correlational data suggesting ratio as a feedback characteristic were
available. In addition to confirming that feedback ratio is a characteristic to consider when implementing feedback, experimentally assessing the effects of feedback ratio advances the behavioral literature on feedback. Often, feedback has been considered a stimulus event; however, in accord with Mangiapanello and Hemmes (2015), it is best considered an operant procedure. Similar to the distinction that Skinner (1953) made between a reinforcer serving as a stimulus and reinforcement involving a relation between behavior and that stimulus, feedback can be applied more technologically by making an explicit distinction between information (i.e., the exteroceptive stimulus) serving as a stimulus and feedback involving the relation between behavior and that stimulus. Given that the stimulus can antecedee or consequeate behavior, the relation is between an antecedent stimulus and behavior, or behavior and a consequential stimulus. As such, this study also extends the literature by conceptualizing feedback as an operant procedure, and proposing that feedback interventions are described in accord with the three components of which they are comprised.

The ways in which this study contributes to the feedback literature, and extends previous research on feedback, provides implications for practitioners in applied contexts. The most straightforward, applied implication of these findings involves improving the technological description of feedback interventions. Using feedback as an intervention requires clearly and completely describing the procedure for its delivery. Addressing that feedback ratio is a characteristic to consider brings attention to the characteristic itself and to the possibility that there may be more than one feedback class to describe. Developing a structural classification system for feedback characteristics provides practitioners a reference for the characteristics to describe when implementing feedback. By improving the clarity and completeness with which
feedback interventions are described, collateral improvements in treatment integrity may be observed.

Some indirect implications of these findings involve proposing a structural classification system and discussing feedback as an operant procedure. Similar to how anatomy (i.e., a branch of biology concerned with studying the structure of organisms and their parts) and physiology (i.e., a branch of biology concerned with studying the function of organisms and their parts) contribute to understanding the human body, classifying feedback characteristics and analyzing their effects contribute to understanding feedback. Using a structural classification system allows practitioners to better understand and describe each component of feedback, and conceptualizing it as an operant procedure allows them to discuss how those components are related. By understanding the structure of each component, and the relation between components, ambiguity about interventions is decreased, replication is enhanced, and more definitive conclusions can be made about the function feedback serves. Although completely characterizing feedback may be impossible given some of its inherent complexities, developing a structural classification system and conceptualizing it as an operant procedure are likely to facilitate clearer and more consistent analyses than currently proposed classification systems and its conceptualization as a physical stimulus.

**Limitations and Future Research**

The following limitations should be improved with future research: (a) include another control group, (b) use an applied environment, and (c) conduct fewer sessions. The lack of an appropriate control group compromises within-group findings, and precludes between-group comparisons. Because the first session for all participants was the control session, sequence and practice effects limit the within-group and across-session findings. By including a control group
in which participants are exposed to confirmation statements for the entire duration of their participation, more confident conclusions could be made regarding the effects of feedback and feedback ratio. Another limitation relates to the extent to which these findings would generalize to an applied environment. As discussed, the applied implications of these findings have great value in settings in which quality or quantity are targeted; however, the extent to which the most effective feedback ratio used in a laboratory translates to the workplace is unknown. As such, it is of greater value to conduct future research in an organizational setting where employees engage in the same task, multiple times each day, and multiples days each week. Although there are limitations on which to improve, these preliminary data suggest that there is value in pursuing research that investigates the feedback ratio.
Appendix A

Scaled Diagram of the Organizational Behavior Management Laboratory
Appendix B

Informed Consent

City University of New York at Queens College
Department of Psychology

CONSENT TO PARTICIPATE IN A RESEARCH PROJECT

Project Title: The Effects of Feedback on Performance

Principal Investigator: Amanda Mentzer; Adjunct Faculty and Doctoral Candidate; Queens College; Science Building, Room E.301; 65-30 Kissena Boulevard, Flushing, NY 11375; 718-997-3224; amanda.mentzer@qc.cuny.edu

Faculty Advisor: Alicia M. Alvero; Associate Professor and Deputy Chairperson; Queens College; Science Building, Room A.308; 65-30 Kissena Boulevard, Flushing, NY 11375; 718-997-3212; alicia.alvero@qc.cuny.edu

Site Where Research Project Is to be Conducted: Science Building, Room E.301; 65-30 Kissena Boulevard, Flushing, NY, 11375

Introduction/Purpose: You are invited to participate in a research project. This research project is conducted under the direction of Amanda Mentzer, a doctoral candidate at Queens College. The purpose of this research project is to better understand how feedback influences performance. The results of this research project may provide scientific evidence for one of the most effective ways to provide feedback.

Procedures: Approximately 90 individuals are expected to participate in this research project. Each participant will be exposed to pre-experimental procedures (i.e., informed consent and a Postural Safety Information Sheet), experimental procedures, and post-experimental procedures (i.e., a survey and debriefing). Your time commitment for this study is approximately 2 hours, and it will involve scheduling one appointment. All sessions will take place in the Organizational Behavior Management (OBM) Laboratory, which is located in Room E.301 of the Science Building at Queens College, City University of New York (i.e., 65-30 Kissena Boulevard, Flushing, NY 11375).

Potential Discomforts and Risks: Your participation in this research project may involve feelings of uncertainty and minor physical discomfort. At times you may feel uncertain about your performance, as feedback will not be provided on every trial. At times you may experience minor physical discomfort, as you will be participating in this research project for a 2-hour appointment. To minimize feelings of uncertainty, please remember that data regarding your performance will remain confidential. To minimize the potential for minor physical discomfort, you will be required to take 2-minute breaks between each session. If you are uncomfortable at anytime during your participation in this research project, please stop what you are doing and address your concerns with the researcher immediately.

CUNY UI - Institutional Review Board
Approval Date: January 11, 2015
Expiration Date: January 10, 2016
Coordinator Initials: sg
If you have questions about your rights as a research participant, or you have comments or concerns that you would like to discuss with someone other than the researchers, please call the CUNY Research Compliance Administrator at 646-664-8918. Alternately, you can write to:

CUNY Office of the Vice Chancellor for Research

Attn: Research Compliance Administrator

205 East 42nd Street

New York, NY 10017

Statement of Consent: “I have read this consent form for The Effects of Feedback on Performance, and I understand what it means to participate in this research project. With respect to this research project, a researcher has explained to me, in detail, the purpose, procedures to be used, potential discomforts and risks, potential benefits, financial considerations, and persons to contact should I have any questions. I understand that participation is voluntary. I understand that I may withdraw from participation at anytime without prejudice, penalty, or loss of benefits to which I am otherwise entitled. I understand that my performance as a participant is and will remain confidential. Other than earning two credits for the Psychology 101 Research Requirement or extra credit points for the Psychology course that I am attending, I understand that my performance as a participant does not influence my role as a student at Queens College or in the course in which I was introduced to this research project. I understand that if I should have questions in the future, the principal investigator will provide me with answers. I do not waive any legal rights to which I am otherwise entitled, and I understand that I will be given a signed copy of this consent form for my records. By signing this consent form, I voluntarily agree to participate in this research project, and I confirm that I am fluent in English.”

Printed Name of Participant

______________________________  ______________________________
Participant Signature Date Signed

Printed Name of Assistant and/or Investigator

______________________________  ______________________________
Signature of Assistant and/or Investigator Date Signed

Institutional Review Board Approval Stamp:

CUNY UH - Institutional Review Board
Approval Date: January 11, 2015
Expiration Date: January 10, 2016
Coordinator Initials:  s
When sitting and typing at a computer, a safe ...

**NECK POSITION** involves (a) the angle between the thoracic vertebrae and cervical vertebrae measuring between 155° and 175°, (b) a forward orientation of the chest such that both shoulders are an equal distance from and in the direction of the monitor, and (c) a forward orientation of the head such that the nose is in the direction of the monitor, the head is balanced between the shoulders, and both ears are an equal distance from the monitor.

**ELBOW POSITION** involves (a) the angle between the upper arm and the forearm measuring between 90° and 110°, (b) a forward orientation of the arms such that both upper arms and both forearms are equal distances from and in the direction of the monitor, (c) a parallel orientation of the arms such that one upper arm and one forearm are an equal distance from the other upper arm and the other forearm, and (d) the upper arms hang close to the body.

**KNEE POSITION** involves (a) the angle between the thigh and lower leg measuring between 90° and 110°, (b) a forward orientation of the legs such that both thighs and both lower legs are equal distances from and in the direction of the monitor screen, and (c) a parallel orientation of the legs such that one thigh and one lower leg are an equal distance from the other thigh and the other lower leg.

**ANKLE POSITION** involves (a) the angle between the lower leg and the foot measuring between 90° and 110°, (b) a forward orientation of the foot such that both lower legs and both sets of toes are equal distances from and in the direction of the monitor screen, and (c) a parallel orientation of the legs and feet such that one lower leg and one foot are an equal distance from the other lower leg and the other foot.
Appendix D

Participant Survey

Date: ___/___/____  Day of Week: _________  Experimental Start Time: ___:____  Participant Number: _______

Participant Survey

Please complete this survey based on your experience as a participant in “The Effects of Feedback on Performance.” Refer to the Participant Survey Information Sheet to better understand Key Terms and Feedback Characteristics. You have as much time as you need, so please take your time. When you complete the survey, exit this room to enter the Main Room, and notify the researcher that you are finished.

Throughout Your Involvement as a Participant

A. How did you feel physically (e.g., your muscles and joints) throughout your participation?

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<th>UNCOMFORTABLE</th>
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What influenced your degree of comfort?

B. How did you feel mentally (e.g., your focus and memory) throughout your participation?

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<th>UNAWARE</th>
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What influenced your degree of awareness?

C. On a scale from 1 (aroused) to 10 (un aroused), how did you feel emotionally (e.g., your mood and feelings) throughout your participation?

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What influenced your degree of arousal?

Research Goal

D. How important is it to determine the most effective feedback statements for improving your behavior?

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How important is it to determine the most effective ratio of complimentary to constructive feedback statements for improving your behavior?

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How important is it to determine the most effective ratio of complimentary to constructive feedback statements for improving all aspects of your behavior (e.g., home, school, and work)?

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How important is it for you to **deliver** the most effective ratio of complimentary to constructive feedback statements?

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How important is it for you to **receive** the most effective ratio of complimentary to constructive feedback statements?

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E. **How important is it to determine the most effective feedback statements for improving societal behavior?**

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How important is it to determine the most effective **ratio of complimentary to constructive feedback statements** for improving societal behavior?

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How important is it to determine the most effective ratio of complimentary to constructive feedback statements for improving **all aspects of societal behavior** (e.g., medicine, politics, poverty, education, and criminal justice)?

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How important is it for society to **deliver** the most effective ratio of complimentary to constructive feedback statements?

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F. **How relevant are feedback statements for improving your behavior?**

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How relevant is the **ratio of complimentary to constructive feedback statements** for improving your behavior?

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How relevant is the ratio of complimentary to constructive feedback statements for improving **all aspects of your behavior** (e.g., home, school, and work)?

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G. **How relevant are feedback statements for improving societal behavior?**

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H. How useful is it to determine the most effective feedback statements for improving your behavior?

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I. How useful is it to determine the most effective feedback statements for improving societal behavior?

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35
How useful is it for society to **deliver** the most effective ratio of complimentary to constructive feedback statements?

| USEFUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | USELESS |

How useful is it for society to **receive** the most effective ratio of complimentary to constructive feedback statements?

| USEFUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | USELESS |

J. Please provide any comments or recommendations that you have related to the **research goal**.

____________________________________________________________________________________

Research Procedure

K. How **acceptable** was it to be exposed to the **pre-experimental procedure** (i.e., interacting with the research assistant, reading the consent form, and reviewing the Postural Safety Information Sheet)?

| ACCEPTABLE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | UNACCEPTABLE |

L. How **acceptable** was it to be exposed to the **experimental procedure** (i.e., interacting with the research assistant, engaging with the computer program, scoring pictures, receiving statements, and taking breaks)?

| ACCEPTABLE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | UNACCEPTABLE |

How acceptable is it to use a **computer program** for determining the most effective ratio of complimentary to constructive feedback statements?

| ACCEPTABLE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | UNACCEPTABLE |

If rated greater than 1, how do you recommend improving its **acceptability**?

____________________________________________________________________________________

How acceptable is it to use the **computer program to which you were exposed** for determining the most effective ratio of complimentary to constructive feedback statements?

| ACCEPTABLE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | UNACCEPTABLE |

If rated greater than 1, how do you recommend improving its **acceptability**?

____________________________________________________________________________________

M. How **acceptable** was it to be exposed to **feedback statements** during the experimental procedure?

| ACCEPTABLE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | UNACCEPTABLE |

How acceptable is it to be exposed to **only complimentary** feedback statements for performing **correctly**?

| ACCEPTABLE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | UNACCEPTABLE |
How acceptable is it to be exposed to only constructive feedback statements for performing incorrectly?

| ACCEPTABLE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | UNACCEPTABLE |

How acceptable is it to be exposed to both complimentary and constructive feedback statements for performing correctly and incorrectly, respectively?

| ACCEPTABLE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | UNACCEPTABLE |

N. How useful was it to be exposed to the pre-experimental procedure (i.e., interacting with the research assistant, reading the consent form, and reviewing the Postural Safety Information Sheet) for understanding:

... what to expect as a participant?

| USEFUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | USELESS |

... why data are being collected?

| USEFUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | USELESS |

... how data will be used?

| USEFUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | USELESS |

O. How useful is it to use a computer program for determining the most effective ratio of complimentary to constructive feedback statements?

| USEFUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | USELESS |

If rated greater than 1, how do you recommend improving its usefulness?

How useful is it to use the computer program to which you were exposed for determining the most effective ratio of complimentary to constructive feedback statements?

| USEFUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | USELESS |

If rated greater than 1, how do you recommend improving its usefulness?

P. How useful was it to be exposed to feedback statements during the experimental procedure?

| USEFUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | USELESS |

How useful is it to be exposed to only complimentary feedback statements for performing correctly?

| USEFUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | USELESS |

How useful is it to be exposed to only constructive feedback statements for performing incorrectly?

| USEFUL | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | USELESS |
How useful is it to be exposed to **both complimentary and constructive** feedback statements for performing correctly and incorrectly, respectively?

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</table>

Q. Please provide any comments or recommendations that you have related to the research procedure.


---

**Research Outcome**

*When this research study is complete, we can provide you with results that suggest what ratio of complimentary to constructive feedback statements is most effective for improving behavior.*

R. How important will these findings be for improving your behavior?

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How important will these findings be for improving all aspects of your behavior (e.g., home, school, and work)?

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How important will these findings be when you deliver feedback statements in the future?

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S. How important will these findings be for improving societal behavior?

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How important will these findings be for improving all aspects of societal behavior (e.g., medicine, politics, poverty, education, and criminal justice)?

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How important will these findings be when society delivers feedback statements in the future?

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T. How relevant will these findings be for improving your behavior?

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U. How relevant will these findings be for improving societal behavior?

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V. How useful will these findings be for improving your behavior?

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How useful will these findings be for improving all aspects of your behavior (e.g., home, school, and work)?

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W. How useful will these findings be for improving societal behavior?

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How useful will these findings be when society delivers feedback statements in the future?

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X. Do you have any comments or recommendations with respect to the research outcome?

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

Participant Details and Participant Rankings

Y. For approximately how many hours did you sleep last night? _____ hours

Z. For approximately how many hours were you using a computer today? _____ hours

AA. For approximately how many hours were you sitting in a chair today? _____ hours
AB. During the hour before you participated in this study, select the activity in which you were mostly engaged?

- assisting with research
- attending laboratory
- attending lecture
- driving
- eating
- relaxing
- socializing
- studying
- working
- other: ________________

AC. Rank the following feedback characteristics, from 1 (most important) to 12 (least important), based on those most important for improving your behavior:

- content
- duration
- medium
- rate
- contiguity
- frequency
- participants
- ratio
- contingency
- inter-feedback interval
- privacy
- source

AD. Rank the following feedback characteristics, from 1 (most important) to 12 (least important), based on those most important for improving societal behavior:

- content
- duration
- medium
- rate
- contiguity
- frequency
- participants
- ratio
- contingency
- inter-feedback interval
- privacy
- source

AE. Rank the following ratios of complimentary (+) to constructive (-) feedback statements, from 1 (most effective) to 5 (least effective), based on those most effective for improving your behavior:

- 10+:0-
- 8+:2-
- 5+:5-
- 2+:8-
- 0+:10-

AF. Rank the following ratios of complimentary to constructive feedback statements, from 1 (most effective) to 5 (least effective), based on those most effective for improving societal behavior:

- 10+:0-
- 8+:2-
- 5+:5-
- 2+:8-
- 0+:10-

AG. Thank you so much for being a part of our study! To increase the value of our findings, it is really important that all participants arrive to the study knowing the same information. In this study, we explain to participants that they will be in a study that assesses the effects of feedback on performance. We would really appreciate if future participants only know the same information, so if you could keep the details of this study private until January 2015, we would be incredibly grateful for your support. As soon as all of our data are collected, we would be more than happy to provide you with an overview of our findings. In the meantime, we have one final request: As a way of making a commitment with us that you will keep the details of this study private until January 2015, please initial here: ___________. Thanks again for your time and effort, and we wish you all the best.
Appendix E

Participant Survey Information Sheet

Key Terms

• FEEDBACK—information about performance that allows an individual to change behavior
  ▪ COMPLIMENTARY FEEDBACK—information about correct performance that allows an individual to maintain or improve performance
    ▪ e.g., “You correctly scored the elbow body position. Maintain performance by referring to the Postural Safety Information Sheet.”
  ▪ CONSTRUCTIVE FEEDBACK—information about incorrect performance that allows an individual to improve performance
    ▪ e.g., “You incorrectly scored the elbow body position. Improve performance by referring to the Postural Safety Information Sheet.”

• ACCEPTABLE—capacity to endure, tolerate, or bear
  ▪ Ask Yourself: How tolerable is it? To what degree can it be endured?

• IMPORTANT—capacity to influence
  ▪ Ask Yourself: How influential is it? To what degree can it influence?

• RELEVANT—capacity to relate, connect, or associate
  ▪ Ask Yourself: How related is it? To what degree can it be associated?

• USEFUL—capacity to provide help or an advantage
  ▪ Ask Yourself: How helpful is it? To what degree can it provide an advantage?

• RESEARCH GOAL—the purpose of systematically investigating a subject area
  ▪ This Research: Determine the most effective ratio of complimentary to constructive feedback statements for improving performance.
  ▪ Ask Yourself: How important, relevant, and useful for you and society is it to know the most effective ratio of complimentary to constructive feedback statements for improving individual and group behavior?

• RESEARCH PROCEDURE—the techniques used to systematically investigate a subject area
  ▪ This Research: Exposes participants to pre-experimental (i.e., informed consent and the Postural Safety Information Sheet), experimental (i.e., interacting with a computer program), and post-experimental (i.e., a Participant Survey and debriefing) procedures.
  ▪ Ask Yourself: Do you consider the procedure for conducting this research acceptable?

• RESEARCH OUTCOME—the results of systematically investigating a subject area
  ▪ This Research: (Given that this research is currently being conducted, the results are unknown.)
  ▪ Ask Yourself: Is knowing the most effective ratio of complimentary to constructive feedback statements for improving individual and group behavior important, relevant, and useful for you and society?
<table>
<thead>
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<th>Feedback Characteristics</th>
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<td>CONTINGUITY</td>
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<td>type of information in feedback</td>
<td>amount of time between behavior and feedback</td>
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<tr>
<td>e.g., another group, individual, or average individual</td>
<td>e.g., 30 seconds, 8 hours, or 1 week</td>
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<td>DURATION</td>
<td>FREQUENCY</td>
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<tr>
<td>amount of time feedback is delivered</td>
<td>total number of feedback statements</td>
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<td>e.g., 30 seconds, 5 minutes, or 1 hour</td>
<td>e.g., 10, 30, or 50</td>
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<td>PARTICIPANTS</td>
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<td>means used to communicate feedback</td>
<td>whose performance is described by feedback</td>
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<td>e.g., graphic, verbal, or written</td>
<td>e.g., group, group + individual, or individual</td>
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<tr>
<td>RATE</td>
<td>RATIO</td>
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<td>number of feedback statements per unit of time</td>
<td>relation between complimentary and constructive feedback statements</td>
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<tr>
<td>e.g., daily, monthly, or weekly</td>
<td>e.g., 10° to 0°, 18° to 2°, or 5° to 5°</td>
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Appendix F

Screenshot of a Trial

Identify the body position that is SAFE

- neck  - elbow  - knee  - ankle
Appendix G

Rating Screenshot

**Feelings about Feedback Messages**

Please rate how you felt about the feedback messages that you received after you scored body positions.

\[\begin{align*}
-100 & \quad \leftarrow \quad \leftarrow \quad 0 & \quad \rightarrow \quad \rightarrow \quad 100 \\
& \quad (Extremely \ Negative) \quad (Neutral) \quad (Extremely \ Positive)
\end{align*}\]

**Instructions:** Click and drag the rectangle to the number that reflects how you felt while scoring body positions and **click OK**.
Table 1

Descriptive Statistics for Groups on Measures across Sessions

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### Table 2

*Immediate, Overall, and Delayed Changes in Performance between Control and Experimental Sessions*

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Figure 1. Layout of the mixed-factorial design used in this study.
Figure 2. A flowchart of the pre-experimental, experimental, and post-experimental procedures used in this study.
Figure 3. Effects of feedback on mean response time (s) during control (i.e., session 1) and experimental (i.e., session 2-7) sessions for all groups. Standard error of the mean is represented by the error bars on each data point.
Figure 4. Effects of feedback on mean percent correct during control (i.e., session 1) and experimental (i.e., session 2-7) sessions for all groups. Standard error of the mean is represented by the error bars on each data point.
Figure 5. Effects of feedback on mean rating during control (i.e., session 1) and experimental (i.e., session 2-7) sessions for all groups. Standard error of the mean is represented by the error bars on each data point.
**Figure 6.** An overview of planned comparisons for separate, one-way repeated measures ANOVAs assessing session effects on mean response time (s), mean percent correct, and mean rating for all groups. Black squares represent statistically significant session effects, and grey squares represent statistically non-significant session effects.
Bibliography


