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The effects of instruction on feedback requests

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HIGHLIGHTS
- Autonomy supportive language led to greater amount of feedback requests.
- Motor skill acquisition was similar regardless of instructional language.
- Instructions can be used to increase or decrease number of feedback requests.

ABBREVIATIONS

AE	Absolute constant error
ANOVA	Analysis of variance
B1-5	Blocks 1-5
CE	Constant error
$\eta 2$	Partial eta-squared
NEED	Do you NEED feedback?
N	No
VE	Variable error
WANT	Do you WANT feedback?
Y	Yes

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BACKGROUND: Self-controlled feedback enhances skill acquisition. Notably, the pattern and frequency of feedback requested varies and impacts the amount of learning. Self-controlled feedback benefits have been attributed to an increase in learner's feelings of autonomy. It is possible that autonomy supportive instructional language modulates feedback requests and consequently skill acquisition.
AIM: We investigated if autonomy-supportive language leads to different pattern and increases frequency of feedback requests and skill acquisition.
METHOD: Forty-two participants (22 women and 20 men) were assigned to a controlling or autonomy supportive instructions group. After each trial, participants were asked "Do you NEED feedback?" or "Do you WANT feedback?", respectively. The task consisted of pressing a specific sequence of 5 computer keys in 1200ms. Then, participants completed 24hrs retention/transfer tests without feedback. During transfer participants performed the same sequence in 1500ms.
RESULTS: Repeated measure ANOVAs indicated participants in the WANT group requested more feedback than participants in the NEED group. Both groups distributed feedback evenly throughout acquisition. No differences in performance in acquisition or in retention/transfer tests were identified.
CONCLUSION: Autonomy supportive instructional language increased feedback requests but not learning. Including measures of feelings of autonomy is encouraged to clarify the mechanisms underlying these findings.

KEYWORDS: Self-controlled feedback | KR | Frequency | Skill acquisition | Motor learning | Autonomy

INTRODUCTION

Allowing learners to decide when to receive feedback has been shown to enhance the acquisition of motor skills compared to externally determined feedback regimens.[1,2] The benefits of self-controlled feedback have been explained from two perspectives.[1,3] One explanation suggests that self-controlled feedback leads to greater engagement in cognitive processes, such as the identification of performance errors,[3,4,5,6] which in turn promotes motor skill acquisition. A more prevalent explanation suggests self-controlled feedback fulfills the learner's psychological needs, like the need for autonomy,[7,8,9,10] which ultimately enhances motor skill acquisition.

Although the benefits of self-controlled feedback are consistently reported, the pattern and frequency of feedback requests that lead to these benefits is varied.[1,11,12] Some studies report a decrease in feedback requests as practice progresses[11,13,14] while others report participants' feedback requests are evenly distributed throughout practice trials.[15,16,17] Additionally, in some studies[14,18] participants request feedback after a relatively low percentage of trials (ranging from an average of 7% to 11% of practice trials) while in others[15,19,20] participants request a relatively high frequency of feedback (ranging from an average of 31.3% to 97% of practice trials).

The frequency of feedback chosen by participants appears to influence skill acquisition. For example, Chiviacowsky, de Medeiros, Kaefer, Wally, and Wulf[21] compared children who requested relatively high frequencies of feedback (i.e., 39.3%) to those who requested relatively low frequencies of feedback (i.e., 8.4%) while learning a beanbag tossing task. The results indicated that participants who requested relatively more feedback performed better in the retention test compared to participants who requested relatively less feedback. The authors argued that the benefits of self-controlled feedback are likely mediated by the feedback frequency requested by the learners. Further, the authors suggest that identifying instructions that impact the frequency of feedback requests could increase the observed benefits of self-controlled feedback.

Examining the effects of instructions on skill acquisition can also provide additional insight into the mechanisms underlying the benefits of self-controlled learning feedback. For example, Hooyman, Wulf, and Lewthwaite[22] examined if instructions that increased learners' feelings of autonomy would enhance the acquisition of cricket pitching to a target compared to controlling or neutral instructions. As mentioned earlier, increased feelings of autonomy as a result of self-controlled feedback have been associated with enhanced learning.[23] Three groups were exposed to either autonomy supportive, controlling, or neutral instructions before practice begin. The results indicated that participants who received autonomy-supportive instructions demonstrated enhanced skill acquisition compared to participants who received controlling or neutral instructions. The autonomy-supportive instructions also led to greater feelings of autonomy, higher self-efficacy and positive affect. The authors argued that the instructions increased learners' feelings of autonomy and in turn enhanced learning. That increase in feelings of autonomy did not, however, lead to statistically significant changes in self-controlled behavior (i.e. pacing) during acquisition. That is, participants did not take advantage of the autonomy afforded to them. This might have happened because participants had limited opportunity to exert control over the learning environment (i.e., participants were only allowed to control pacing), differences in the content of the instructions themselves (i.e., participants in the autonomy supportive group were told "feel free to go at a pace you are comfortable with" while participants in the controlling group were told that "you must maintain a consistent pace"), or limited exposure to the instructions (i.e., participants were only given the instructions once at the beginning of practice).

In the present study, we investigated if autonomy-supportive language leads to different pattern and frequency of feedback requests and skill acquisition. Primarily, we expected that participants exposed to language that promoted autonomy would request more feedback than those who were exposed to more controlling instructions and that the differences between groups in feedback requests would increase during the acquisition phase. Secondarily, we expected that language promoting autonomy would lead to increased retention of a motor skill compared to instructions containing more controlling language.

METHODS

Participants and experimental groups

Forty-two right-handed college-aged volunteers (22 women and 20 men) free from cognitive or sensory-motor impairments participated in the experiment. Sample size was based on Lohse, Buchanan, and Miller[24] who noted that most motor learning experiments are underpowered citing a selected group of experiments with a median n/group = 11. Therefore, we selected a n/group = 21. In-class announcements were used to recruit participants at a large public university in southern California. Participants were free from musculoskeletal injuries and sensory-motor or cognitive impairments. Participants were inexperienced with the task and naïve to the purpose of the experiment. They were quasi-randomly assigned to one of two experimental groups: NEED (M_{age} =21.14, SD_{age} = 1.74 years), and WANT (M_{age} = 20.10, SD_{age} = 2.17 years). Participants in the NEED group were presented with a screen that read “Do you NEED feedback? Y/N” and participants in the WANT group were presented with a screen that read “Do you WANT feedback? Y/N” after every trial. All other instructions were identical. Campbell[25] indicates that although individuals sometimes use the words “need” and “want” interchangeably in casual conversations, in the context of consumption (i.e., using resources available to them), they are aware of the critical differences between the two terms and use them differently in achieving their goals. Additionally, Wilensky[26] argues that the words “need” and “want” are perceived differently. The author indicates that “need” is used when it refers to something that is a necessary precondition or action for the subject’s goal. “Want” is used when it refers to something that is itself the subject’s goal, given that the goal is not one of preservation or obligation. Indeed, O’Boyle[27] defines a need as something indispensable while a want is something desired. Further, avoiding instructions that contain certain words, like “have to” or “must”, can increase learners’ sense of choice and flexibility.[28] In the present context then, asking participants if they need feedback suggests feedback is indispensable, or something that they have to have, and as such restricts participants to only request it when it is absolutely necessary. On the other hand, asking participants if they want feedback allows learners more freedom in deciding if feedback would or not be appropriate for that trial. Quasi-random group assignment matched the number of women and men in each group. All procedures were approved by the university’s Institutional Review Board.

Task and material

The task consisted of pressing five computer keys sequentially (3-6-5-8-4) in exactly 1200ms (Figure 1). Previous literature has demonstrated advantages of self-controlled feedback in the acquisition of this type of task.[6,15,16,17,19,29] The use of this task then allows for the comparison of the frequency of feedback requests in this experiment to others in the self-controlled feedback literature. The task was performed on the numeric pad of a standard keyboard on a desktop computer. Custom software (E-Prime 3.0, Psychology Software Tools, Inc., Pittsburg, PA, USA) was used to provide general information about the task, specific instructions regarding feedback requests, feedback, and to collect data. Information about the task, specific instructions regarding feedback requests and feedback were displayed on a standard computer monitor.

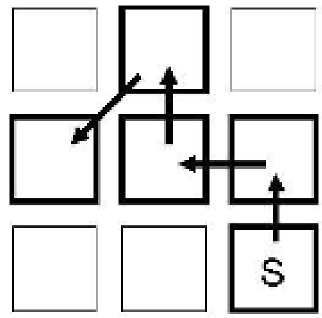

Figure 1. Key-pressing sequence and goal movement time. Fig. 1 depicts the sequence used for both experimental phases and the goal movement time for acquisition. For the transfer test, goal movement time was 1500ms. Once this diagram was displayed, participants were allowed to start. The diagram was visible until the last key was in the sequence was pressed.

Procedures

Data collection was conducted individually in a secluded room. The experiment included two phases held on two consecutive days: acquisition and retention/transfer. During the acquisition phase, participants were given a brief overview of the experimental task and asked to read and sign the informed consent form. After providing consent, participants were seated in front of a desktop computer and asked to read the instructions on the screen, then explain the instructions back to the experimenter. During the acquisition phase participants completed 50 trials of the experimental task. A trial began with “Ready?” display on the screen for 2 seconds, then a diagram with the sequence and goal movement time (Figure 1) was displayed. Participants could then start to press the keys when they were ready. Once the participant pressed the first key, time started to be recorded (i.e. movement time). The diagram remained on the screen throughout the response. Once the last key of the sequence was pressed a blank screen appeared for one second. Participants in the NEED group were then prompted with the question “do you NEED feedback? Y / N” after every trial. In the WANT group, participants were prompted with the question “do you WANT feedback? Y / N” after every trial. After the prompt, participants would press “Y” to receive feedback or “N” to move on to the next trial without receiving the feedback. Feedback consisted of sequence errors (i.e., if the sequence was completed correctly or not), and constant error (i.e., the difference between movement time and goal movement time). No sequence errors were observed. Feedback, if requested, was presented on the screen for 2 seconds. If participants did not request feedback, a blank screen was displayed for 2 seconds.

Approximately 24 hours later, participants completed a 10-trial retention test and a 10-trial transfer test, in which the goal was to perform the same sequence in 1500ms. No feedback was provided during retention or transfer tests. The retention/transfer phase lasted approximately 10 minutes.

Measures

Participants’ choice regarding feedback was recorded for every trial. Additionally, the time elapsed from the pressing of the first key to the pressing of the final key in the sequence (i.e. movement time) was recorded. Constant error (CE) was calculated as the difference between movement time and goal movement time for each trial. The dependent variable used to investigate the effects of instruction on pattern and frequency of feedback requests was number of feedback requests in each 25-trial block. The dependent variables used to assess performance and learning of the task were: 1) mean CE, calculated by averaging the CE obtained in each 10-trial block; 2) mean absolute constant error (AE), obtained by calculating the mean of absolute CE in each 10-trial block; 3) mean variable error (VE), the standard deviation of the CE obtained in each 10-trial block. Schmidt and colleagues[30] indicates that these measures of performance are typically used in motor learning research and provide different insight into the performers' capabilities.

Analyses

To test the effects of instruction on the pattern and frequency of feedback requests, a 2 (groups: NEED; WANT) by 2 (blocks of 25 trials: first; last) analysis of variance (ANOVA) with repeated measures on the last factor was conducted. Changes in performance and differences between groups during acquisition were tested via separate 2 (groups: NEED; WANT) by 5 (blocks of 10 trials: B1, B2, B3, B4, B5) repeated measures ANOVAs for CE, AE, and VE. Performance and differences between groups on the retention and transfer test were tested via separate 2 (groups: NEED; WANT) by 2 (tests: Retention; Transfer) repeated measures ANOVAs for CE, AE and VE. These statistical analyses are fairly typical in the literature on autonomy support[22] and self-control[21,22] given the number of groups, nature of the measurements, and repetitive nature of the performance. As an additional measure for skill retention, separate 2 (groups: NEED; WANT) by 2 (blocks of 10 trials: B1, RET) repeated measures ANOVAs for CE, AE, and VE were included as secondary analyses. A visual examination the data suggested no outliers and approximate normal distribution for the vast majority of the dependent variables. Where appropriate Levene's test of homogeneity of variances was used. The vast majority of the dependent variables met the assumptions for the chosen analyses. When the sphericity assumption was violated the Greenhouse-Geisser adjusted values are reported. Partial eta-squared (η^2) is reported as an estimate for effect size. Sidak post hoc procedures were used when appropriate. For all analyses, alpha level was set at 0.05, and SPSS® V21 software was used.

RESULTS

Feedback Requests

Table 1 depicts feedback requests during acquisition for participants in the NEED and WANT groups. Participants in the WANT group requested more feedback than participants in the NEED group. It also appeared that participants requested slightly more feedback in the second half of the acquisition phase than in the first half. The ANOVA partially confirmed these observations indicating a group effect ($F(1, 40) = 4.175$, $p = .048$, $\eta^2 = .095$) but no block effect ($F(1, 40) = 1.525$, $p = .224$, $\eta^2 = .037$) or block by group interaction ($F(1, 40) = .731$, $p = .398$, $\eta^2 = .018$).

Table 1 – Table 1 contains the mean and standard deviation (M±SD) of the number of feedback requests by the NEED and WANT groups in total, and in the first and second half of trials. The results of the ANOVA indicate a significant effect for group in total number of feedback requests.

	Number of Feedback Requests			Percentage of Feedback Requests		
GROUPS	Total	1st half	2nd half	Total	1st half	2nd half
NEED	43.8±6.2	21.4±4.2	22.4±2.9	88%±12	86%±17	90%±11
WANT	47.1±4.2	23.5±2.8	23.8±2.1	94%±8	94%±11	95%±8

Mean Constant Error (CE)

Figure 2 indicates that participants in all groups had relatively low and constant CE during acquisition. It also seems that CE in transfer, particularly for participants in the WANT group, was higher than in retention. The ANOVA indicated no block effects (F(3.146, 125.841) = 1.268, p = .288, η^2 = .031), no block by group interaction (F(3.146, 125.841) = .678, p = .574, η^2 = .017), and no group effect (F(1, 40) = .002, p = .964, η^2 = .000). In the retention and transfer phase, the ANOVA indicated no group effects (F(1, 40) = 1.583, p = .216, η^2 = .038) or group by test interactions (F(1, 40) = 1.166, p = .287, η^2 = .028) for CE. It did however, identify a significant main effect for test (F(1, 40) = 4.344, p = .044, η^2 = .098). Participants had higher CE in transfer than in retention (see TABLE 2). Further, the secondary analysis 2 (groups: NEED; WANT) by 2 (blocks of 10 trials: B1, RET) repeated measures ANOVA for CE indicated no main effect for block (F(1, 40) = .554, p = .461, η^2 = .014), group (F(1, 40) = 1.234, p = .273, η^2 = .192), or group by block interaction (F(1, 40) = .099, p = .755, η^2 = .002).

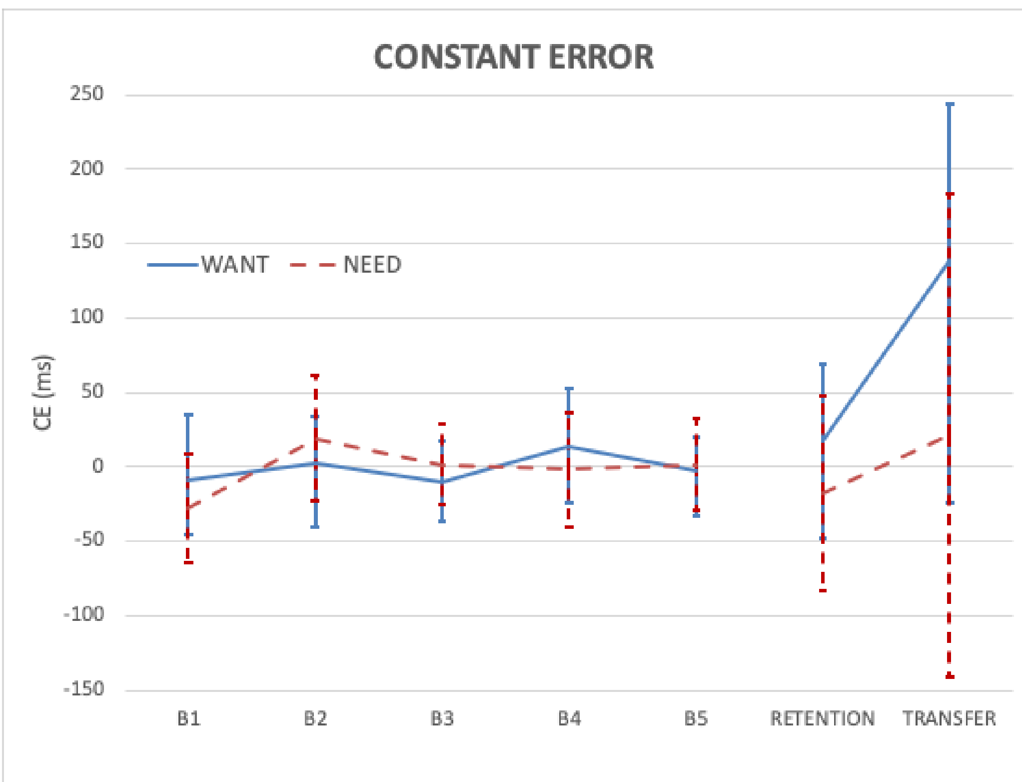

Figure 2. Constant Error. Fig. 2 depicts mean CE (with 95% confidence intervals) in the acquisition (B1-B5) and RETENTION and TRANSFER for the NEED (in red) and WANT (in blue) groups (The reader is referred to the web versions for references to color).

Mean Absolute Error (AE)

For AE the ANOVA indicated block effects (F(3.157, 126.262) = 13.915, p < .001, η^2 = .258). Post hoc analyses indicate mean AE in B1 was higher than in B2 (p = .004), B3 (p < .001), B4 (p < .001), and B5 (p < .001) (see TABLE 2). However, no block by group interaction (F(3.157, 126.262) = .939, p = .428, η^2 = .023) or group effect (F(1, 40) = .055, p = .815, η^2 = .001) were identified (Figure 3). In the retention and transfer phase, the ANOVA indicated no group effects (F(1, 40) = .885, p = .352, η^2 = .022) or group by test interactions (F(1, 40) = .600, p = .443 η^2 = .015). Similarly to CE, for AE a main effect for test (F(1, 40) = 25.795, p < .001, η^2 = .392) was identified. Participants had higher AE in transfer than in retention (see TABLE 2). Further, the secondary analysis 2 (groups: NEED; WANT) by 2 (blocks of 10 trials: B1, RET) repeated measures ANOVA for AE indicated a main effect for block (F(1, 40) = 11.148, p = .002, η^2 = .218), but no significant main effect for group (F(1, 40) = .180, p = .674, η^2 = .004), or group by block interaction (F(1, 40) = .128, p = .723, η^2 = .003). Participants had higher mean AE in the first block of acquisition (161.30ms±58.77) than in retention (118.40ms±80.79).

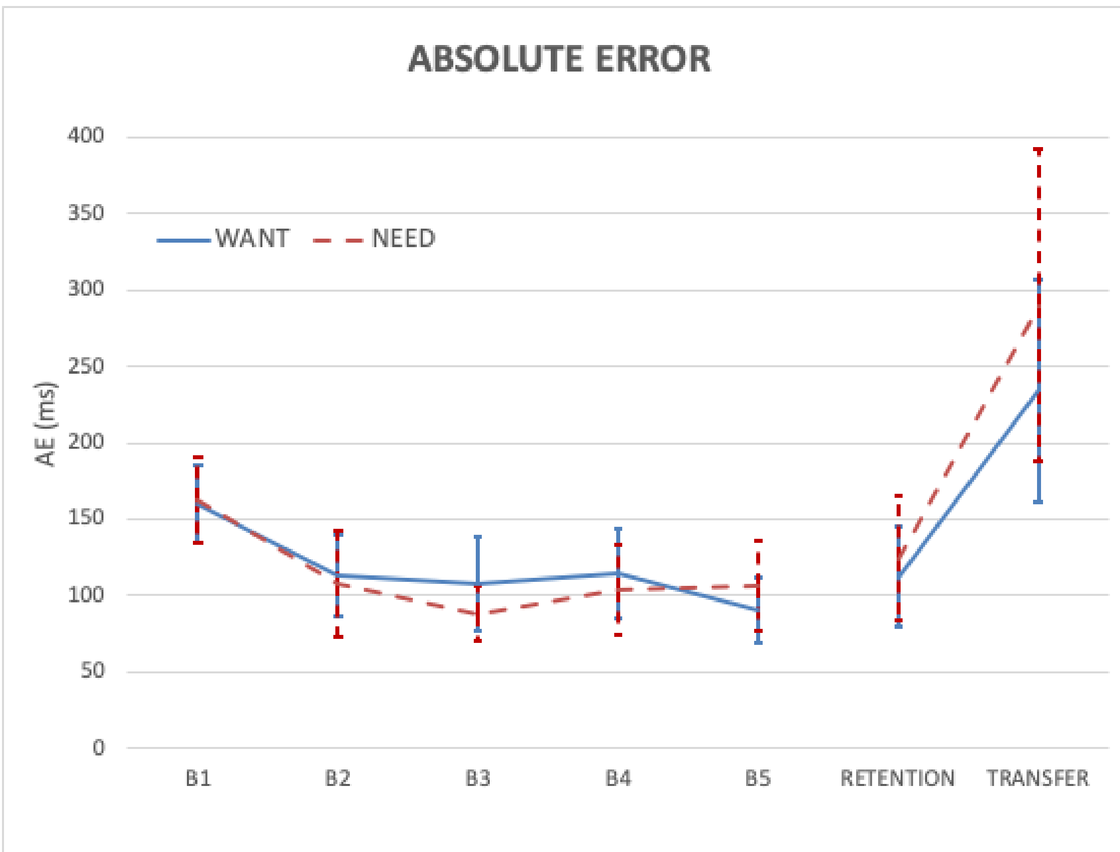

Figure 3. Absolute Error. Fig. 3 depicts mean AE (with 95% confidence intervals) in the acquisition (B1-B5) and RETENTION and TRANSFER for the NEED (in red) and WANT (in blue) groups (The reader is referred to the web versions for references to color).

Mean Variable Error (VE)

In the acquisition phase, the ANOVA indicated a block effect ($F(2.830, 113.188) = 6.768$, $p < .001$, $\eta^2 = .145$). Post hoc analyses indicate mean VE in B1 was greater than in B3 ($p < .001$), B4 ($p = .008$) and B5 ($p < .001$) (see TABLE 2). No block by group interaction ($F(2.830, 113.188) = .957$, $p = .412$, $\eta^2 = .023$), or group effect ($F(1, 40) = .468$, $p = .498$, $\eta^2 = .012$) were identified (Figure 4). In the retention and transfer phase, the ANOVA indicated no group effect ($F(1, 40) = .400$, $p = .531$, $\eta^2 = .010$) or group by test interaction ($F(1, 40) = 1.098$, $p = .301$, $\eta^2 = .027$). There was a significant main effect for test ($F(1, 40) = 8.323$, $p = .006$, $\eta^2 = .172$). Participants had higher VE in transfer than in retention (see TABLE 2). Further, the secondary analysis 2 (groups: NEED; WANT) by 2 (blocks of 10 trials: B1, RET) repeated measures ANOVA for VE indicated a main effect for block ($F(1, 40) = 27.851$, $p < .000$, $\eta^2 = .410$), but no significant main effect for group ($F(1, 40) = 1.689$, $p = .201$, $\eta^2 = .041$), or group by block interaction ($F(1, 40) = .104$, $p = .749$, $\eta^2 = .003$). Participants had higher mean VE in the first block of acquisition (206.82ms±105.13) than in retention (99.34ms±80.92).

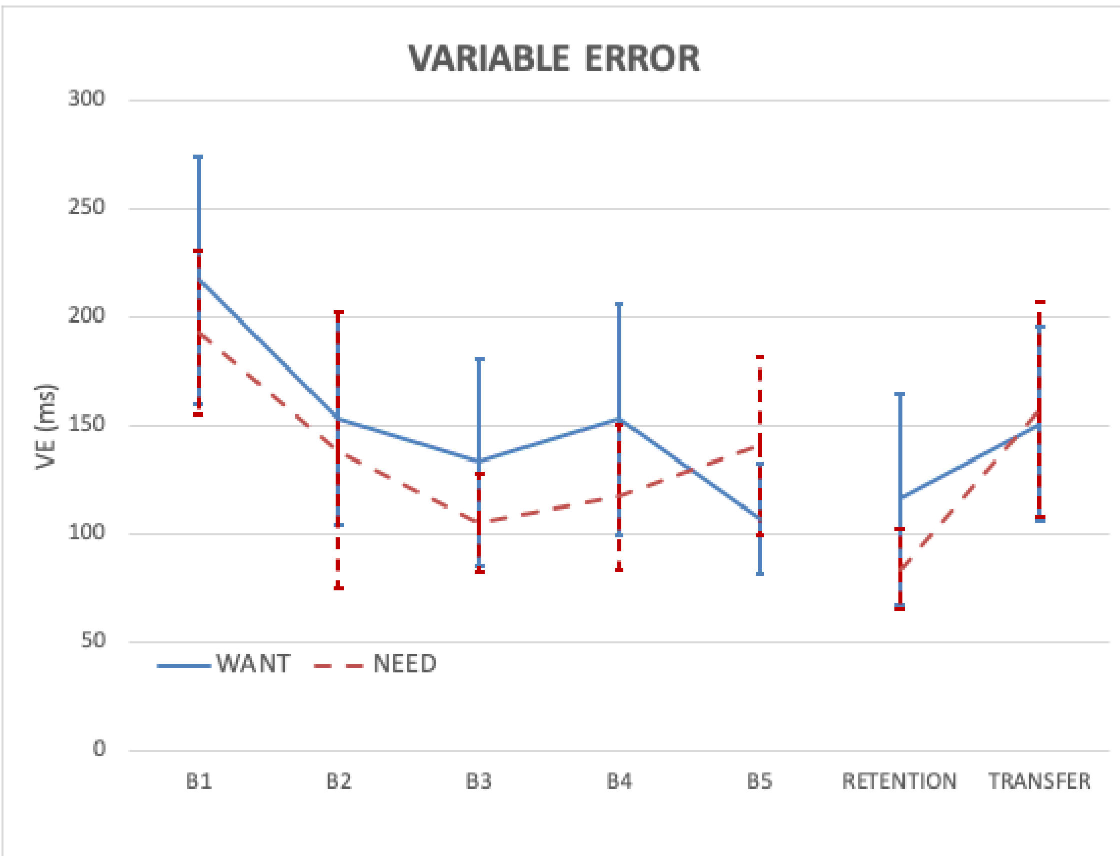

Figure 4. Variable Error. Fig. 4 depicts mean VE (with 95% confidence intervals) in the acquisition (B1-B5) and RETENTION and TRANSFER for the NEED (in red) and WANT (in blue) groups (The reader is referred to the web version for references to color).

Summary of Results

Taken together the results indicate that there were no differences in performance between participants in the NEED and WANT groups. Further, both groups improved performance across acquisition and had generally higher error scores in the transfer test compared to the retention test. Additionally, secondary analyses indicated that participants generally performed better in retention than in the first block of acquisition. The results also indicate that participants in both groups requested feedback evenly throughout the acquisition phase. And lastly, participants in the WANT group requested feedback more frequently than participants in the NEED group.

TABLE 2 – Table 2 contains mean and standard deviation (M±SD), in milliseconds, for CE, AE, and VE during acquisition (B1-B5) and RETENTION and TRANSFER phases. Data for the NEED and WANT groups and total are included.

GROUPS		B1	B2	B3	B4	B5	RETENTION	TRANSFER
NEED	CE	-28±80	19±93	2±58	-2±84	2±67	-17±144	21±356
	AE	163±63	108±75	88±40	104±64	107±65	125±90	290±223
	VE	197±83	135±140	107±50	121±73	141±91	83±40	157±108
WANT	CE	-8±97	2±70	-10±61	14±83	-3±49	17±115	138±232
	AE	160±56	113±59	108±69	114±64	91±47	112±72	234±160
	VE	217±125	153±108	133±105	153±117	107±56	116±106	151±98
TOTAL	CE	-18±88	11±82	-4±59	6±83	0±58	0±130	80±303
	AE	161±59	111±67	98±57	109±64	99±56	118±81	262±194
	VE	207±105	144±124	120±82	137±98	124±76	99±81	154±102

DISCUSSION

Allowing learners to control their feedback schedules has been shown to promote motor learning compared to yoked feedback schedules.[2] This advantage of self-controlled feedback has been linked to an increase in learners' sense of autonomy.[23] The pattern and frequency of feedback requests has been varied[11] and has been shown to impact the amount of motor learning.[13] Further, instructional language that promotes autonomy has led to increase motor skills[13] acquisition compared to controlling language.[22] Therefore, it is possible that the instructional language used in the self-controlled feedback literature, which is under reported,[1] might modulate feedback requests and, consequently, skill acquisition. Here, we investigated if participants exposed to language that promoted autonomy (i.e., WANT group) would request more feedback than those who were exposed to more controlling instructions (i.e., NEED group) and that the differences between groups in feedback requests would increase during the acquisition phase. Additionally, we expected participants in the WANT group to demonstrate superior learning compared to the NEED group. As stated by Chiviacowsky and colleagues,[13] identifying language that increases or decreases feedback requests may be a way to increase the benefits of self-controlled feedback manipulations, as the amount of feedback requests in self-controlled feedback studies appears to influence the amount of learning.

This study demonstrates that instructions indeed impact the frequency of feedback requests. Specifically, participants who were asked if they wanted feedback requested more feedback than participants who were asked if they needed feedback. The word "need", that tends to be associated with something that participants have to do and thus more controlling,[28] led participants to reduce the number of feedback requests. The word "want", that is associated with something that is desired[26,27] and thus presumed to be more autonomy supportive, led participants to increase the number of feedback requests. These results may at least in part explain the different frequency of feedback requests reported[11] in the self-controlled feedback literature. Identifying the relationship between instructions and feedback frequency requests may prove difficult since the specific instructions used in the self-controlled feedback literature seldomly are reported.[1] Given that the frequency of feedback request has an influence on learning[13] and our results indicating that instructions influence the feedback frequency requests, highlights the importance of a thorough description of the instructions used in self-controlled feedback studies.

Our results also indicate that instructions did not have an impact on the pattern of feedback requests, that is, participants in both groups requested feedback evenly during practice. We expected that, as participants were exposed to the instructions during the acquisition phase, the difference in feedback requests would become more pronounced. This hypothesis was developed based on Hooyman, Wulf and Lewthwaite[22] suggestion that, in their study, participants did not take advantage of the autonomy afforded to them because they had only been exposed to the instructions at the beginning of the practice phase. Here, it seems that the information conveyed by the words “need” and “want” was evident early in the acquisition phase and additional exposure to the instructions did not change the learners’ perceptions of the autonomy afforded in the learning situation. It is worth noting that the pattern of feedback requests reported in the self-controlled feedback literature is varied[11] and the specific instructions used in these studies is under reported[1] so contextualizing our findings within the current literature is challenging. However, based on the limited evidence provided in this study, it appears the fading feedback frequency observed in some self-controlled feedback studies[11,13,14] is unlikely to be linked to the learner’s feeling of autonomy.

Although the autonomy supportive language led to a higher frequency of feedback requests, it did not lead to enhanced motor skill acquisition as it did in Hooyman, Wulf and Lewthwaite. [22] Wulf and Lewthwaite[23] and Hooyman, Wuf, and Lewthwaite[22] suggest that autonomy supportive language increases learners’ sense of autonomy and consequently enhances skill acquisition. Based on the present results, perhaps that is not always the case. In the present study, we assumed participants in the WANT group experienced a greater sense of autonomy compared to participants in the NEED group. This was based on the arguments posited by O’Boyle,[27] Su and Reeve,[28] and Wilensky[26] and on the statistically significant difference in frequency of feedback requests. However, we did not measure participants’ sense of autonomy. It is possible that the instructions did not impact the learners’ sense of autonomy which would explain the similar skill acquisition. Another possible, and perhaps more likely, explanation for the lack of difference in skill acquisition might be the, although statistically significant, relatively small difference between the frequency of feedback requested by the WANT (94%) and NEED (88%) groups. Chiviacowsky and colleagues[13] were able to demonstrate that children who requested less feedback (8%) showed less effective skilled acquisition (39%) than children who requested more feedback. However, in their study, all children received the same instructions and the groups were formed after completing the practice phase, so it is possible the learners who requested less feedback were overall less engaged with the learning task which led to the lower frequency of feedback requests and skills acquisition.

CONCLUSION

In conclusion, the present study demonstrates that instructions can have an impact on the frequency of feedback requests. This reinforces the importance of including detailed methodological information in self-controlled feedback studies to fully understand its effects. Further, our results appear to suggest that autonomy supportive language does not always lead to better skill acquisition. However, our ability to make firm conclusions is limited given the lack of a measurement of the learners' sense of autonomy. This is a limitation of the present study that should be addressed in the future.

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