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Empirical Research

The effects of bilingual Acceptance and Commitment Training (ACT) on exercise in bilingual international university students

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ABSTRACT

Promoting physical activity is a crucial public health priority. Interventions that use applied behavior analytic procedures (ABA) such as contingency management and self-management have shown promise for facilitating physical activity. However, additional research is needed to advance innovation, particularly with respect to interventions that work through indirect-acting contingencies. Among these innovative models of behavior intervention, Acceptance and Commitment Training (ACT) has received increased attention and empirical support. Previous research has provided evidence that ACT can increase exercise but previous ACT studies have generally used group designs, which makes it difficult to carefully consider the effects of the intervention at the level of the individual participant, the level at which ACT trainers and therapists work. The present study evaluated a bilingual, five-week, one-on-one ACT-based coaching program for increasing exercise in bilingual international university students. After receiving the ACT intervention, all four participants increased their average daily steps, gym visits, and gym duration significantly and gains maintained after intervention was terminated. The results of this study suggest that an ACT-based bilingual coaching program of moderate duration can be effective for increasing exercise in bilingual university students.

Physical activity plays an important role in prevention and management of many non-communicable diseases, including cardiovascular diseases, diabetes, obesity, depression, and various types of cancer (Warburton, Nicol, & Bredin, 2006). Previous research shows that a daily 10,000 step goal is beneficial for maintaining a desirable level of physical activity for health; however, there is a deficit of approximately 4000 daily steps among adults (Choi, Pak, & Choi, 2007). Research has shown that increasing daily steps is reliably associated with decreasing negative health outcomes in heart disease and diabetes (Kraus et al., 2019). In order to maintain substantial health benefits, the 2008 U.S. Department of Health and Human Services (HHS) federal physical activity guidelines recommend that adults perform muscle-strengthening activities at least twice weekly, with moderate-intensity aerobic physical activity for at least 150 min per week or vigorous-intensity aerobic physical activity for at least 75 min per week. However, despite the numerous health benefits of regular exercise, only 22.9% of U.S. adults aged 18–64 met the guidelines for both aerobic and muscle-strengthening activities during leisure-time physical activity (LTPA) in 2010–2015 (Blackwell & Clarke, 2018).

Applied behavior analytic (ABA) interventions that use procedures such as contingency management and self-management have shown promise for increasing physical activity. Contingency management interventions include components such as arranging the environment to make objective verification of some target behavior possible and providing tangible reinforcers contingent on participant's emitting the target behavior (Petry, 2000). In Kurti and Dallery (2013), the experimenters used an Internet-based intervention and changing criterion design to increase walking in 12 sedentary participants over 50 years of age. The results of their study showed that steps increased 182% from baseline to the end of intervention, and 87% of step goals were met. Washington, Banna, and Gibson (2014) employed a reversal design to further examine the effectiveness of CM and their findings suggested that all 11 healthy adults in their study increased overall steps by improving daily minutes active, within-bout response rates, and decreasing pauses between bouts of activity.

Self-management is also considered an effective intervention to increase physical activity. Normand (2008) utilized a self-management strategy to promote physical activity of four nonobese adults and the results indicated that including self-monitoring, goal setting, and feedback were successful at increasing the total number of steps per day. A

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similar study conducted by Donaldson and Normand (2009) used the same components and all participants in their study were successful in increasing the daily caloric expenditure during intervention phases. In both studies reviewed above, the experimenters included feedback (delivered via daily e-mails) in their treatment package and asked participants to submit data via e-mail. However, another study conducted by VanWormer (2004) used a component analysis, which indicated that self-monitoring alone (without the feedback) was effective for all participants and only one participant showed further improvement when receiving e-mail feedback. Hustyi, Normand, and Larson (2011) evaluated self-monitoring, goal setting, and reinforcement to promote physical activity (steps per session) but their results showed modest or no increases in physical activity. The experimenters noticed that the rewards they used for these two obese children may not have functioned as reinforcers. Van Camp and Hayes (2012) also mentioned that in order to increase physical activity, more research is needed to identify effective reinforcers when self-monitoring, goal setting, and feedback are not sufficient.

Although it has been demonstrated by previous research that self-management and contingency management appear to be promising for increasing physical activity, given the social significance of the topic (Van Camp & Hayes, 2012), additional research is needed to advance innovations in behavioral interventions, especially those that move beyond direct-acting contingencies. Third-wave behavioral therapies leverage both direct and indirect-acting contingencies, through mindfulness techniques and willingness to tolerate distress via valued behavior change (Butryn, Forman, Hoffman, Shaw, & Juarascio, 2011). Among these innovative models of behavior interventions, Acceptance and Commitment Therapy (ACT) has received substantial attention and empirical support.

Acceptance and Commitment Therapy (ACT) is a form of psychotherapeutic treatment that has been widely used in clinical settings for the treatment and management of psychological disorders such as depression (Zettle & Rains, 1989), anxiety (Block, 2002), and substance use (Hayes et al., 2004). More recently, it has been applied to health-related behaviors, including self-management of diabetes (Gregg, Callaghan, & Hayes, 2007) and weight loss for obesity (Lillis, Hayes, Bunting, & Masuda, 2009). ACT is considered a third-wave behavioral therapy, that incorporates acceptance-based procedures, mindfulness-based procedures, and traditional behavior change strategies, and is based upon a behavior analytic conceptual analysis of language and cognition (Sandoz, Boullion, & Rachal, 2020).

Although originally developed as a behavior analytic approach to psychotherapy, ACT has been increasingly implemented outside of psychotherapeutic contexts in recent years. Accordingly, the term Acceptance and Commitment *Training* has come to denote ACT implemented outside of psychotherapy, whereas Acceptance and Commitment *Therapy* refers to ACT inside of psychotherapy (Tarbox, Szabo, & Aclan, 2020). ACT therapy is implemented by professionals who are competent in psychotherapy, including psychologists, psychiatrists, counselors, and social workers, among others. ACT training is implemented by behavior analysts, physical therapists, nurses, among others. Of course, mental health professionals also can implement ACT training in training-oriented settings (e.g., businesses) and some professionals are credentialed in both training-oriented professions (e.g., behavior analysts) and therapy-oriented professions (e.g., psychologists). Space does not permit a full discussion of this topic here and readers are referred to a recent publication that discusses ACT training inside the scope of practice of applied behavior analysis, which was the setting of the current study (Tarbox et al., 2020).

We predict that ACT could be effective for helping increase physical activity for several reasons. First, physical activity can be uncomfortable, especially when first initiating a new exercise routine. Values work in ACT may address this functionally by transforming the function of unpleasant stimuli through motivative augmentals (e.g., "Having sore muscles is worth it because it means I'm working on being healthier for my family"). In addition, like most other aversive situations, exercise (and even thinking about exercise) likely evokes rigid thinking (i.e., covert verbal rules) that contributes to avoidant behavior. For example, "I'm just too busy to exercise tonight, I'll start tomorrow," or "I can't go to the gym unless they are teaching the specific class I want." Defusion training procedures from ACT may help disrupt the function of these verbal stimuli as rules that contribute to avoidant behavior and therefore create an opportunity for a person to choose a behavior different from avoidance, for example, committed action toward an exercise-related value.

Most studies applying ACT-based procedures to physical activity have included participants with obesity. Few studies have focused on using these procedures in people who are not diagnosed with obesity but wish to improve their exercising habits and few still have investigated ACT for increasing physical activity at the level of the individual participant. In Butryn et al. (2011), the experimenters evaluated the short-term effectiveness of a brief, physical-activity-focused ACT intervention for the purpose of facilitating physical activity in nonobese individuals. A total of 54 females were randomly assigned to an education (n = 19) or ACT (n = 35) intervention. Both interventions consisted of two, 2-h group sessions in which participants in the ACT sessions were taught skills for mindfulness, values clarification, and willingness to experience distress in the service of behavior change and the participants in the education intervention were provided information about safely engaging in physical activity. The dependent variables were participant self-reports of athletic center visits, mindful awareness, and the degree of psychological distance from various negative thoughts and feelings. The overall results of their study suggested that participants in the ACT sessions increased their willingness to engage in physical activity more significantly than participants in the education group and made more frequent athletic center visits, as reported at 3 weeks post-intervention. However, the experimenters did not assess how long the participants stayed in the athletic center (how much actual physical activity) and only relied on self-report measures to document effectiveness.

Initial research suggests ACT can teach people how to increase their willingness to exercise by accepting and defusing from unpleasant internal experiences (e.g., exercise-related discomfort). A study by Ivanova, Jensen, Cassoff, Gu, and Knaeuper (2015) tested the efficacy of an acute intervention derived from ACT for increasing high-intensity constant work rate (CWR) exercise tolerance in sedentary women. A total of 39 women were randomly assigned to the experimental group (ACT; n = 18) or the control group (no ACT-techniques; n = 21). During the ACT condition, participants were taught cognitive defusion and acceptance techniques to cope with aversive physical discomfort and negative affect by increasing their willingness to experience unpleasant physical sensations. For the no-ACT condition, participants were shown a short video and then created goals for increasing their overall physical activity levels. The results of this study suggested that exercise tolerance increased by 15% in the ACT group. The results are encouraging but the study was very short-term (approximately 1 h in duration) and was conducted in a contrived laboratory setting. Therefore, it is unknown whether the intervention would result in socially meaningful behavior change in participants' real lives.

Ivanova, Yaakoba-Zohar, Jensen, Cassoff, and Knäuper (2016) attempted to evaluate the longer-term effectiveness of ACT on exercise by comparing it to an implementation intentions intervention in promoting physical activity and exercise enjoyment and evaluated the effects at 6-months follow-up. 32 nonobese women were randomized into either ACT training (n = 16) or instructions to form implementation intentions for exercise activities (n = 16). Participants in the ACT intervention were instructed in how to manage unpleasant physical sensations and psychological responses to exercising. Participants in the implementation intentions group were provided with psycho-education on physical activity and taught to form concrete plans to increase physical activity. The results of the interventions were measured

through a self-report questionnaire at six months post-intervention. Since the two interventions were effective in increasing physical activity and exercise enjoyment long term, the study does not provide evidence of effectiveness of ACT, per se.

Overall, the studies briefly reviewed above provide some initial examples of the effects of ACT interventions on improving short-term and long-term physical activity. The results thus far are encouraging and much more research on the use of ACT for increasing physical activity is still needed. All previous research, of which we are aware, has used group designs without considering each participant's individual differences. In particular, studies that evaluate the effects of specific ACT exercises on repeated measures of multiple overt behaviors, that do not rely only on self-report, and that are analyzed at the level of the individual participant are needed. In addition, no previous research, of which we are aware, has evaluated ACT for increasing physical activity in multilingual or culturally diverse populations. The lack of diversity in research participants is recognized as a major limitation of modern health science, not only ethically but practically, and seriously hinders society's ability to extrapolate findings to the general public from research primarily done with Caucasian participants (Oh et al., 2015). Therefore, the purpose of the present study was to extend previous research by using a single case design to evaluate the effects of a multilingual ACT-based coaching program for increasing measures of the overt behavior of physical activity in bilingual non-obese adults.

1. Method

1.1. Participants and setting

Participants of this study were four bilingual college students whose original language was Mandarin Chinese, ages 21–29 years old, who were medically healthy, could safely engage in physical activity, and reported that they wanted to increase their physical activity and had failed to do so on their own in the past. Participant demographic information is depicted in Table 1. All participants reported that they had been to the gym before but participated in <150-min/week of moderate and/or <75-min/week vigorous exercise for the past 2 months. Body mass index (BMI) was not considered as a criterion for inclusion in the study as physical activity is expected to be of potential benefit to any person, regardless of weight status. Weight management was not a target of the current study.

Intervention sessions took place in a room within a university campus, which contained several tables and chairs, and the participants engaged in physical exercise in their natural environment (e.g., gym and park). The experimenters included one monolingual English-speaking faculty advisor (second author), one graduate student whose native language was Mandarin and who also spoke English (first author), and the third author who spoke only English.

1.2. Response measurement and interobserver agreement

Three dependent variables were included in the current study: daily steps taken, frequency of gym visits, and duration of gym visits.

Steps taken. The primary dependent variable was the number of average daily steps taken per week. The Mi band 2 activity band was used in this study because it had been reported to have high accuracy and tight integration with Apple Health and Google Fit platforms compared to other activity bands (El-Amrawy & Nounou, 2015). The Mi band 2 is an activity-tracking band that is worn on the wrist, which can wirelessly connect with participants' mobile phones. Each participant was given a Mi band 2 before beginning baseline and each participant's daily steps were automatically collected and uploaded via Bluetooth into the Mi Fit App on the participant's phone during all phases of the study. To report data to the first author, participants were asked to take screenshots of their daily steps from the app on their phone and send the pictures to the experimenter by 11:59 p.m. each day. The activity band used to track the primary dependent variable was given to each participant as compensation for their participation.

Frequency and duration of gym visits. The frequency and duration of gym visits were measured daily and summarized weekly. The participants were instructed that, every time they entered the gym, to take photos of their gym visit and send them to the first author, and record the duration of each gym visit on their phone. They sent their photos of gym visits and duration of each gym visit for the week to the experimenter by Sunday night. In addition, the first author corroborated the frequency and duration of gym visits by comparing participants' duration data collection to the patterns of physical activity recorded by the activity band. The patterns of physical activity recorded by the activity band include a visual display of the number of steps taken per hour for every hour of every day. Therefore, if a participant reported attending the gym from 5 to 6 p.m. on a given day, the experimenter would visually inspect the number of steps taken before 5 p.m., from 5 to 6 p.m., and after 6 p.m. If indeed the participant had engaged in physical activity between 5 and 6 p.m., it was easily identifiable that an increase in physical activity occurred during that hour, via visual inspection.

Social Validity. Social validity was assessed via a written assessment at the conclusion of the study for each participant. Social validity assessment questions covering the validity of goals, procedures, and outcomes, are listed in Table 2. Note that the intervention program was described to participants as "mindfulness techniques" rather than as ACT, as this was deemed to be more familiar and the purpose of the study was not to educate the participants on the meaning of the term ACT, per se.

1.3. Procedures

A multiple baseline across participants design was used, consisting of the following phases: baseline, ACT intervention, and maintenance.

Baseline. After receiving the activity band to measure their Steps taken, participants were told to engage in their normal pattern of exercise. No feedback was given to the participants based on any of their data, other than thanking them for reporting data. Data collection procedures were the same in baseline as in the other phases.

Table 1
Participant demographics.

Participant	Gender	Age	Race	BMI	BMR
1	Female	23	Asian	22	1361
2	Male	29	Asian	20	1630
3	Male	23	Asian	25	1908
4	Male	21	Asian	23	1891

Table 2
Social validity assessment questions and scores across participants.

Social Validity Assessment					
1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree					
	Par 1	Par 2	Par 3	Par 4	Mean
I believe that the mindfulness procedures used in this study helped me realize my true value of doing exercise.	5	5	5	5	5
I found that the mindfulness procedures used were easy to follow.	5	5	5	5	5
I prefer to receive instructions in my primary language.	3	4	5	4	4
I value the goal of exercising more.	5	5	5	5	5
The mindfulness exercises used in this study were helpful in my daily life.	5	5	4	5	4.75
Participating in this study helped me improve my exercise behavior.	5	5	5	5	5
Overall, I approve of the mindfulness procedures used in this study.	5	5	5	5	5

Intervention. Intervention sessions were conducted one-on-one, in person. Training was provided verbally, with occasional use of paper handouts, e.g., the values bull's eye and goal-setting worksheets. Participants were allowed to take worksheets used during sessions home with them. The program targeted five of the six core processes of ACT, excluding self-as-context, and focused primarily on values and committed action. Self-as-context was excluded because we were attempting to make the intervention as brief as possible and we have observed that self-as-context is sometimes the most abstract and potentially difficult-to-master of the ACT processes. Values discussions were focused on relating participants' chosen values to the behavior of physical activity, e.g., "What personal values would doing exercise help you move toward?" All participants received the same first training session, which was 1 h and 10 min in duration and consisted of the first six exercises listed in Table 3. 30-minute weekly sessions were then conducted, consisting of two exercises from the list on Table 3. The values bull's eye and goal setting exercises served as the anchor of the program and were conducted during all sessions. The goal-setting exercises were used to create context for the participants to set their own goals for the number of gym visits and steps taken per week. Sessions were scheduled once per week at approximately the same day and time each week, according to participant availability. A total of five training sessions were conducted, with a total cumulative duration of all training sessions averaging 190 min per participant.

All participants were informed that the study would be conducted in English but that Mandarin translation was available at any time, from the first author. Participants were reminded of this at the beginning of each session and the total proportion of sessions that were translated depended on the amount of translation that each participant requested during any given session. All sessions for participant 1 were conducted in English and the first author translated approximately five percent of the words spoken during sessions into Mandarin. Participant 2 requested that approximately sixty percent of the sessions were conducted in Mandarin. Participant 3 reported having more difficulty understanding instructions in English and requested that the intervention be translated into Mandarin approximately eighty five percent of the time. Participant 4 did not request any translation into Mandarin.

Maintenance. After the fifth intervention session, participants were instructed to continue wearing the activity band and continue to report data to the experimenter the same way as in baseline and intervention. They met with the experimenter every two weeks to discuss their progress and exercise status but no further ACT training was conducted. No specific performance feedback was given but general positive regard was provided for continuing to track their behavior and remaining committed to physical activity.

Debriefing. During the final in-person meeting in the maintenance phase, participants were debriefed on the overall purpose and processes used throughout the study as well as the outcomes attained. Participants were given the opportunity to ask any questions about the study and its conclusions and were asked to complete the social validity assessment.

Table 3
ACT exercises used during each session of the intervention phase.

Session	Exercise	Reference
1	Values bull's eye (revisited each session)	Lundgren, Luoma, Dahl, Strosahl, and Melin (2012)
	Goal setting (revisited each session)	Bailey, Ciarrochi, and Harris (2014)
	Five Senses	Stoddard and Afari (2014)
	Mindful bodyscan	Stoddard and Afari (2014)
	Ball in a pool	(Stoddard and Afari (2014))
	Identifying barriers to exercise	Egan et al. (2013)
2	Talking and listening	Harris, 2009, p. 177
	Observer exercise	Hayes et al., 1999, pp. 192-196
3	Mind-reading machine	Harris, 2009, p. 201
	The master storyteller	Harris, 2009, p. 119
4	What do you want your life to stand for?	Hayes et al., 1999, pp. 215-218
	Passengers on the bus	Hayes et al. (1999)
5	Word repetition	Titchener, 1916
	Silly voice	Hayes & Strosahl (2004)

2. Results

Fig. 1 depicts the average daily Steps per week for all participants. The horizontal dotted lines depict participant-selected goals. Participant 1 experienced baseline for three weeks and her daily steps on average were 1739 steps. Her daily steps increased significantly to 5076 steps during ACT intervention and increased further in the maintenance phase (5310 steps on average). For participant 2, his average daily steps during the first baseline condition (four weeks) was 2432. His daily steps increased to 7152 steps after two ACT intervention sessions. However, he experienced a family emergency and needed to return to China. He requested that his study participation be put on hold but agreed to continue to report data to the experimenter while on hold. While intervention was on hold, his daily steps decreased to an average of 3313

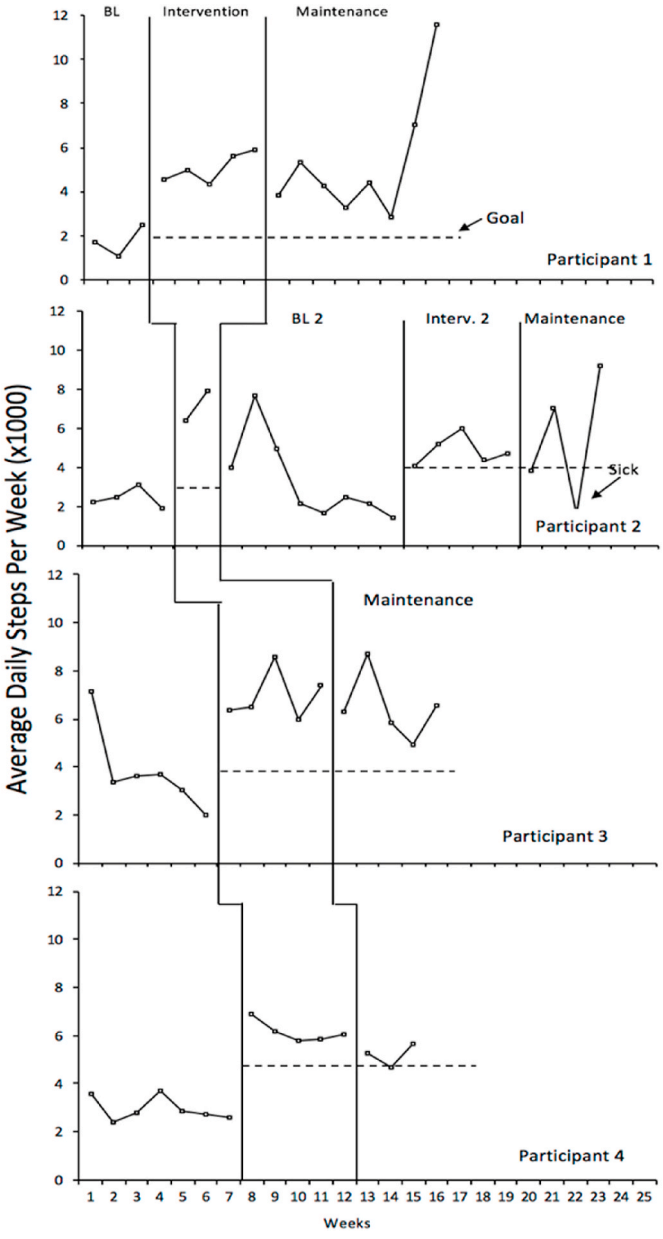

Fig. 1. Average daily Steps per week.

steps for the seven weeks he was in China and the first week he was back in the US but not yet back participating in the intervention. Intervention was then reinitiated and his daily steps increased to an average of 4852 steps. He achieved his highest daily steps during the maintenance condition (7005 steps). Participant 3 experienced baseline for six weeks and his average daily steps were 3801. His daily steps increased significantly to 6969 steps during ACT intervention and maintained at an average of 6447 steps per week during the maintenance condition. Participant 4 experienced baseline for seven weeks and his daily steps on average were 2942. His daily steps increased significantly to 6290 steps during ACT intervention and averaged 5201 in maintenance. The percentage of non-overlapping data points, comparing baseline to intervention phases were 100% for participant 1, 100% for participant 2, 40% for participant 3, and 100% for participant 4.

Fig. 2 depicts the frequency of weekly gym visits. Participant 1's gym visits increased from zero in baseline to an average of 3.4 during intervention and 3.3 during the maintenance condition. No data are reported for week 14, as her gym was closed for construction. Participant 2's gym visits increased from zero in baseline to twice per week in both intervention and maintenance sessions, aside from week 22, in which he was sick. Participant 3's gym visits increased from zero in baseline to an average of 2.2 per week during intervention and an average of 3 during the maintenance condition. Participant 4's gym visits increased from zero in baseline to 2.4 times per week during

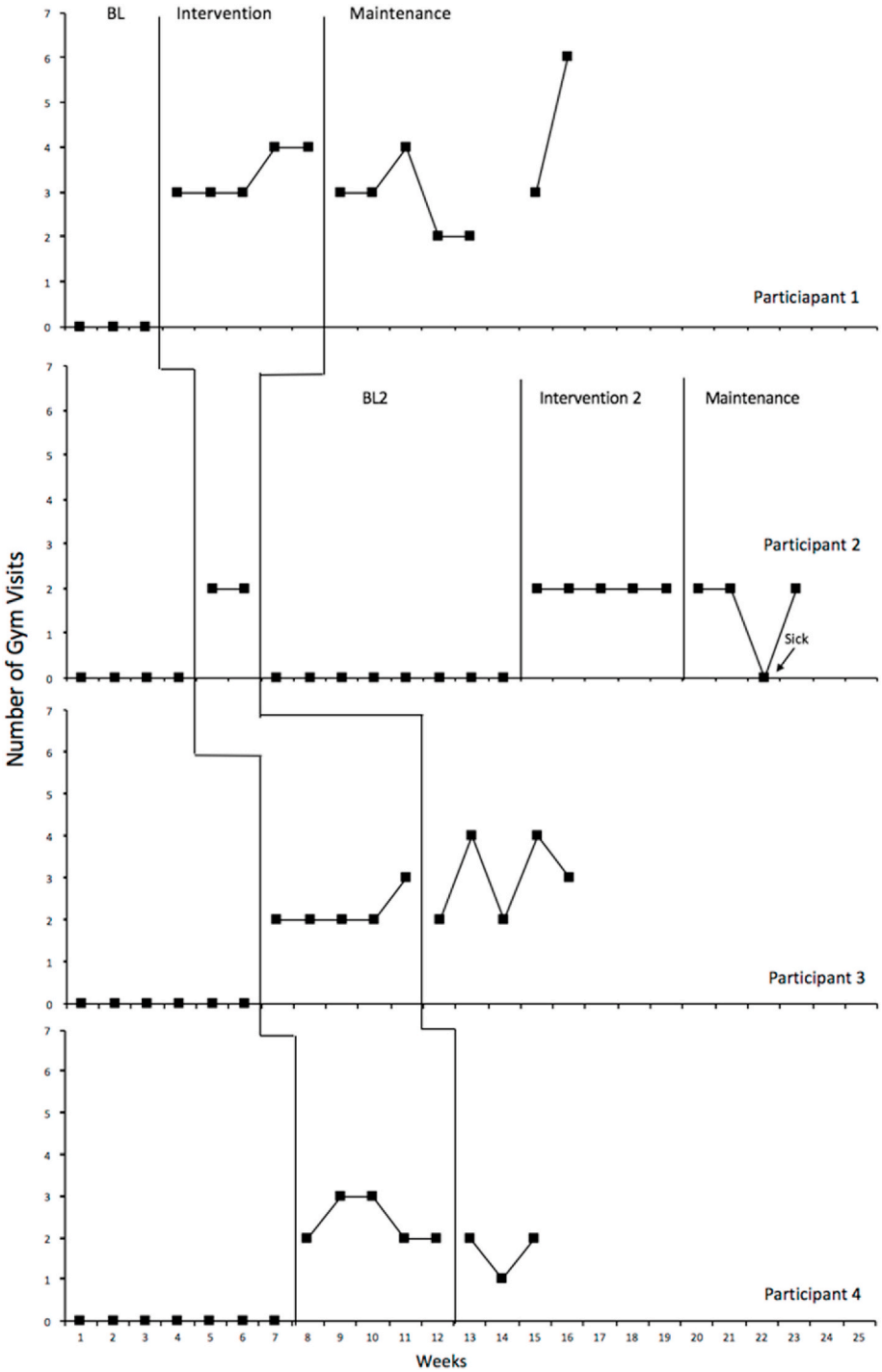

Fig. 2. Frequency of gym visits per week.

intervention and 1.7 during maintenance. The percentage of non-overlapping data points, comparing baseline to intervention phases, was 100% for all participants.

Fig. 3 depicts the weekly average duration of gym visits. Participant 1's gym visit duration increased from zero in baseline to an average of 3.55 h per week in intervention and an average of 3.9 h per week in maintenance. Participant 2's work out duration increased from zero in baseline to an average of 1.9 h per week across all intervention weeks (pre and post break in intervention) and an average of 2 h per week in the maintenance condition, including week 19, during which he was sick. Participant 3's work out duration per week increased from zero in baseline to an average of 2.49 h per week in intervention and 3.15 h per week in maintenance. Participant 4's gym visit duration increased from zero hours per week in baseline to an average of 1.2 h per week in intervention and an average of 1.17 h per week in maintenance. The percentage of non-overlapping data points, comparing baseline to intervention phases, was 100% for all participants.

Table 2 depicts the data from the social validity assessment for all participants. Overall, the participants found the study socially acceptable. The lowest score was in response to the statement "I prefer to receive instructions in my primary language," for which the mean score was 4, corresponding to a response of "Agree."

3. Discussion

Facilitating physical activity is a significant public health concern, as increasing physical activity is linked to a variety of positive health outcomes (Kraus et al., 2019). To address the wide-ranging barriers to physical activity, it is critical to evaluate innovative approaches that target physical activity. This study provides preliminary evidence suggesting that a five-week multilingual ACT intervention may produce immediate and substantial increases in physical activity among international bilingual college students, as evidenced by increases in daily Steps, gym visits, and duration of gym visits. The results of this study suggest that ACT-based interventions can be effective in both English and Chinese for bilingual participants. In addition, the intervention was brief, requiring relatively little overall contact time with the experimenter (i.e., under 4 h total). Finally, the effects of the intervention maintained after it was discontinued, however no long-term follow-up data were collected.

Given the increasing rates of preventable disease and death caused by exercise-related personal health decisions, some speculation regarding the larger implications of these findings may be in order. This study investigated a very specific population (i.e., international students at one university) but the effectiveness of the intervention suggests that ACT-based interventions could be potentially developed for promoting physical activity in other populations (e.g., people with obesity or diabetes) and, potentially, for creating prevention programs at an earlier age. For example, it seems possible that building greater psychological flexibility surrounding exercise during childhood could potentially reduce the probability of developing a sedentary lifestyle and the negative health outcomes associated with it at a later time. Of course, this study did not investigate such a possibility, but future research should attempt to train ACT skills related to exercise in school children and directly measure exercise behavior and health outcomes in adulthood.

The role of ACT in creating flexibility in cognitions surrounding exercise warrants discussion. Contemporary society, particularly social media, is replete with messages that people *should* exercise and aversive private verbal statements (i.e., thoughts) surrounding exercise are likely common (e.g., "I don't look good in gym clothes," "People are going to stare at me at the gym," etc.). The highly selective nature of images that people choose to post on social media, including digitally enhanced pictures, likely create a context that is highly effective at evoking and maintaining negative and avoidant statements about body image and exercise that, when functioning as verbal rules that rigidly control behavior, likely support exercise-avoidant behavior. It seems likely that the current intervention helped establish more flexible and values-oriented cognitions (i.e., private verbal rules) surrounding exercise, for example, participant 4 anecdotally reported that "I developed more ways of exercise and fell in love with running on the playground in the evening." Unfortunately, because we made no attempt to systematically measure such private verbal behavior, future research should attempt to do so more thoroughly.

The implications of the current study for culturally adapted interventions for diverse populations may also be worthy of discussion. The current study evaluated one possible approach for extending English language interventions into diverse, multilingual populations. In this case, the monolingual professor demonstrated the intervention for the initial sessions with the first participant and responsibility for implementing the intervention was gradually transferred to the bilingual graduate student first author. She then adjusted her own implementation of the intervention by flexibly switching back-and-forth from English to Mandarin, at the request of each individual participant. One might argue that this represents an inconsistent or uncontrolled implementation of the independent variable. However, given the highly consistent results across participants, it also seems possible that this approach represents a step toward flexible, culturally and contextually adapted implementation of ACT interventions.

We argue that including multilingual populations in this study and delivering the intervention in a multilingual format is a strength of the current study in that it reflects a larger scientific value of increasing equitable access to research and service to more diverse populations. Previous researchers have noted that the lack of diversity in research participants presents a barrier to our ability to generalize the results to the diverse world in which we all live, and just as importantly, reflects a lack of willingness to engage diversity as a serious and important priority in the research process (Oh et al., 2015). The current study represents one very small but important step toward extending acceptance and commitment training research and practice toward linguistically diverse populations.

One limitation of this study is that the intervention was conducted in a university setting; thus, it is not possible to determine if the results generalize to more natural settings. However, it is worth noting that, while the training sessions took place in a university setting, the participant behavior change occurred in their regular everyday lives (e.g., their gyms in the community). In addition, since the participants were university students, the university actually was their natural setting. Still, future research should replicate the current procedures in other settings, such as gyms, schools, psychology practices, and medical settings. A second limitation is that only four healthy bilingual college students were involved in this study. Much more additional research is needed by other research groups and across other populations and settings.

A further potential limitation is that, since we did not conduct a component analysis, it is impossible to determine whether all components of the training program were necessary. Self-as-context was not explicitly included in the program. It is possible that some of the other five hexaflex components of the training program could have been omitted and/or fewer than five sessions could have been conducted. However, the current intervention was a relatively small investment in time and it obtained a relatively large change in a behavior that can be very hard to change. Still, future research could conduct component or parametric analyses that identify the necessary components and dose for optimal effectiveness.

In addition, we did not individually assess the effects of experimenter feedback on participant goals (e.g. Pingo, Dixon, & Paliliunas, 2019). While doing so could have enhanced the precision of the current study, it is also reasonable to argue that most committed action work with a trainer involves either implicit or explicit experimenter feedback, simply because reflecting on one's behavior from the previous week, relative to one's committed actions, inherently involves a form of feedback.

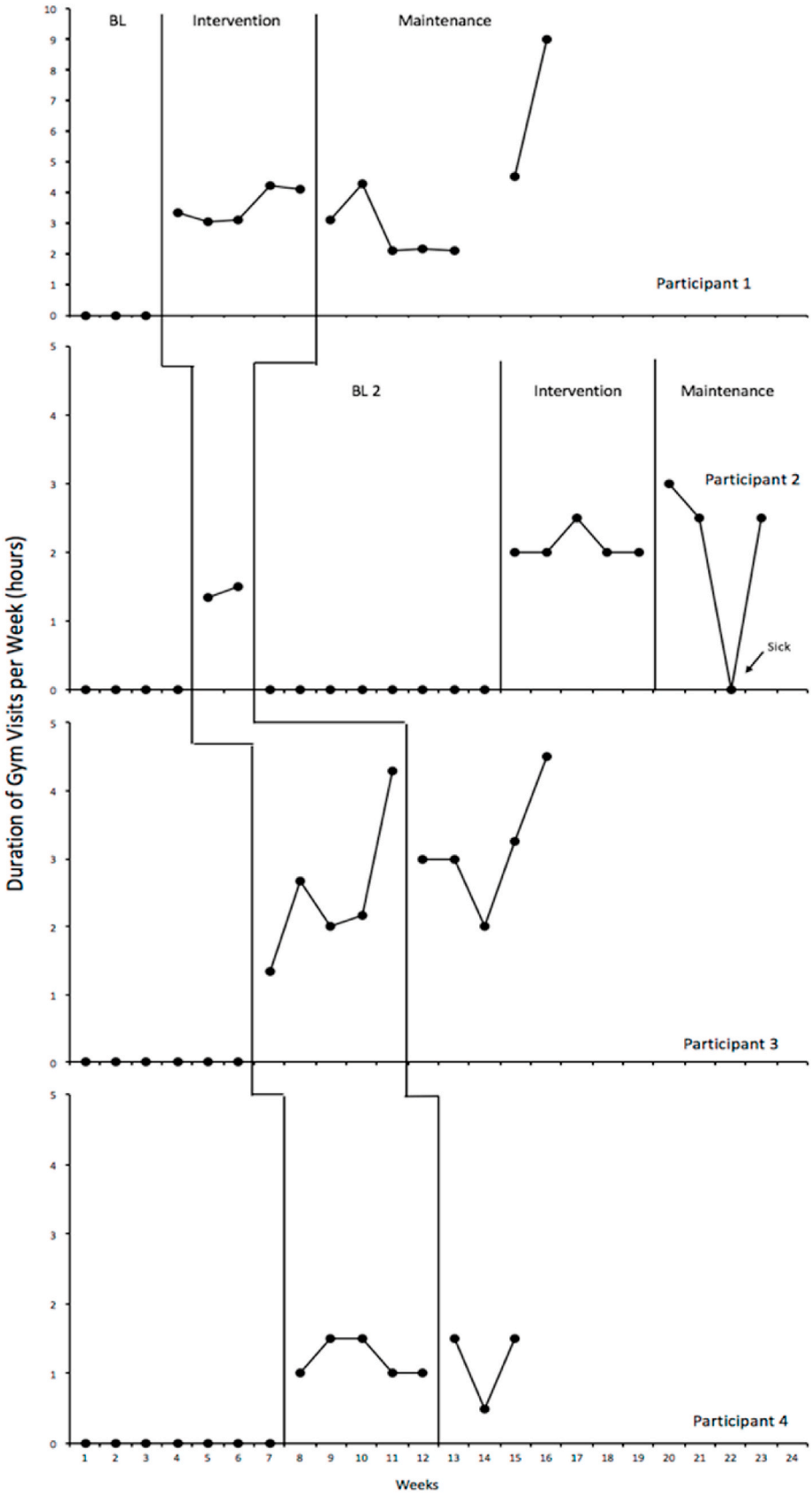

Fig. 3. Weekly work out duration.

Therefore, completely eliminating any form of implicit or explicit experimenter feedback may be difficult or impossible while still implementing the committed action procedures, which are a core component of ACT.

Another potential limitation of the current study is that we did not include any subjective measures of psychological flexibility or well-being. We excluded subjective measures because the purpose of the study was to increase overt measures of physical activity. We also interpret the primary goal of ACT as being to help people increase overt behaviors that lead them toward their values; therefore, our perspective is that directly measuring those overt behaviors is the most direct manner to measure the success of an ACT intervention. Still, since measuring psychological flexibility would help corroborate that changes in psychological flexibility accompanied changes in overt values-directed behavior, future research may wish to include such measures.

In conclusion, research on ACT for increasing physical activity is still in its infancy but the initial evidence is encouraging. This study advances available knowledge by analyzing the results at the level of the individual participant over time, using repeated measures of the behavior of interest. Furthermore, the intervention was relatively brief and the effects maintained after training was discontinued. We hope that the procedures used in this study, as well as future research on ACT and physical activity, help people develop flexible, positive relationships with exercise that may contribute to their future health and well-being.

Declaration of competing interest

The authors declare they have no conflicts of interest to disclose.

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