“Move into Another World of Happy”: Insights for Designing Affect-Based Physical Activity Interventions

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ABSTRACT
Physical activity yields affective benefits like mood improvement and a sense of accomplishment or a general sense of feeling good. However, existing interventions to promote physical activity typically do not make tracking or visualization of affective benefits a prominent part of the interface. We conducted a survey asking people about physical activity episodes that made them feel good and the impact of those episodes on their exercise intentions. We found that the affective benefits of exercise motivated respondents to become more active. In this paper, we report on the affective benefits that resulted from exercise, what users perceived as causing those affective benefits, and what impact feeling good from being active had on their intentions for future exercise. We discuss the implications of our findings for the design of interventions that use affective benefits to promote physical activity.

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Consumer Health; Personal Informatics; Behavior Change; Affective Computing; Fitness; Physical Activity

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INTRODUCTION
Writing in 1980 on the pervasiveness of affective responses, Zajonc speculated that “the very first stage of the organism’s reaction to stimuli and the very first elements in retrieval are affective” [31]. These affective impulses and states guide much of our judgment and decision making, often at an unconscious level (c.f., Kahneman 2011 [14]). They also affect our behavior.

Physical activity is known to influence people’s affective states. Although there is mixed evidence whether this is true for everyone [1] and whether this effect holds for all exercise intensities [8], for the most part physical activity is understood to give people a positive affective boost [11]. This can happen in or outside the lab [9], and positive affective benefits can be felt during the exercise session [30], directly after the exercise session, and shortly after the exercise session [9]. There is also some evidence that positive affect during exercise is associated with exercising in the future [23], but the evidence on this is mixed [30]. Other factors like the individual’s existing exercise habits or the intensity of the exercise may also interact with the affective benefits individuals reap from physical activity [13,17,22,23,30].

Despite a strong link between positive affective benefits and physical activity, HCI researchers have not yet fully explored ways to leverage positive affective benefits in behavior change interventions. Wearables and other mobile health applications are extremely personal devices that are always at hand and have ever-expanding capabilities for tracking and visualizing multiple data types [15]. To better understand how mobile technologies can leverage positive affective benefits to encourage physical activity, we did a survey about the affective benefits people experienced from different activity types, and the effect those experiences had on people’s exercise habits.

In this paper, we:

- Investigate the connection between the experience of affective benefits from exercise and intentions for future physical activity;
- Describe the types of affective benefits people experience from different types of physical activities, and the reasons why they experienced those benefits; and
- Discuss the implications of these findings for the design of physical activity interventions.

MOOD AND ACTIVITY TRACKING IN HCI
The HCI community has devoted much attention to the design and development of interventions to promote physical activity. Many of these interventions focus on tracking step count (e.g. [3,11]), although others allow users to log other types of activity that are not as easily tracked automatically, like weight-lifting (e.g. [5]). In research so far, where affect and physical activity are both tracked in the same system, the goal has typically been to track or improve the user’s affective state rather than to encourage

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physical activity. Affective Diary [28] captured movement and affective arousal in the same innovative visualization, but its purpose was to encourage reflection and investigate the appeal of embodied visualizations rather than to promote physical activity. Systems like Monarca [2] and Empath [7] track activity as well as mood in the service of managing mental health conditions like bipolar disorder and depression. Byrne et al. 2010 used mobile phones to detect patterns in users' gaits in order to infer their mood [3]. Mark et al. 2016 created a system that tracked subjects' physical activity in order to assess its correlation with their mood, and found mixed results about the link between the two [18], while another system that used smartphone sensors to understand the user's mood found a positive correlation between activity and mood [20]. Another system, HealthAware, monitored the effect of its advice on both activity and stress levels [26], but treated them as separate rather than interconnected dimensions of health. This body of work has much to offer in terms of tracking and monitoring of users' affective states, but the techniques developed in these and other works to track or influence user affect have not yet been applied to motivate physical activity. Additionally, because they focus on mood management, these systems focus on the correlation between physical activity and mood rather than the *reasons* for the impact of specific activity sessions on mood. In other words, these systems were not designed to determine if some activities or activity types produced different effects on mood than others. Given that physical activity and positive feelings are closely linked, further work is needed to understand how information about the affective benefits of exercise can be harnessed to motivate physical activity.

METHODS

We conducted a survey asking respondents to tell us about a physical activity experience that "made them feel good". We focused on positive affective impacts because the goal of the survey was to understand how to leverage positive affect in technological interventions to promote physical activity. The questions were intentionally left open-ended so that respondents could report any kind of physical activity episode. To encourage participants to report a range of episodes rather than just special events that might be expected to yield an emotional high, we furthermore began the first question with a reminder that routine physical activity can also yield positive feelings. Respondents were asked to tell us about the activity they had performed and to describe how it had made them feel, what about the event had made them feel that way, and if they had to overcome any obstacle to perform the activity. Further questions asked if the episode was routine or unusual, who they had performed the activity with, whether they had recorded or shared anything about the activity, and if so, what they had recorded or shared. Importantly, respondents were asked whether that particular experience had made them want to change anything about their future exercise routine. Respondents were also asked about their demographic information and general activity level over the past six months. At the end of the survey, respondents were offered the opportunity to enter a raffle for Amazon gift cards. The survey was hosted online and distributed through email lists, Facebook networks, and personal connections. Responses to the four open-text questions (about the activity they performed, how it made them feel, what about the event had made them feel good, and what obstacles they had overcome to perform the activity) were coded iteratively by the research team using open coding, as described in [6]. IRB exemption was granted by the researchers' institutional review board.

RESULTS

Respondents described a mix of routine and unusual events, resulting in a variety of affective benefits. Respondents moreover reported making changes to their exercise routines as a result of the experiences described. This finding held across activity levels and activity types.

Respondents

Of a total of 282 respondents, 56% reached the end of the survey, although not all respondents answered every question. The 44% "partial" responses were empty: respondents answered no questions, only opened the survey to look. We report statistics and analysis on the 158 respondents who reached the end of the survey. Respondent characteristics are reported in Table 1. Almost all respondents (n=149) were located in the United States; 2 were located in Canada, 2 in India, 1 in Paraguay, 1 in Argentina, and the location of 3 respondents was not identified. Respondents were not asked about their occupation.

Respondents	n	%*
Total completed surveys	158	
Gender		
Male	44	28%
Female	109	69%
Other / Not specified	4	3%
Age		
18-24	24	15%
25-34	83	53%
35-44	29	18%
45+	22	14%
Activity level		
Consistently active	91	58%
Inconsistently active	47	30%
Not very active	15	10%
Other	5	3%

Table 1. Summary of respondents. *Not all respondents answered every question; percentage given is of total n who answered that question.

Respondents were asked about their gender, age, and activity level. *Consistently active* was defined as "at least 90 minutes of moderate or intense activity a week, with few exceptions"; *inconsistently active* was defined as "some weeks I get at least 90 minutes of moderate to intense activity, but I haven't consistently maintained it for 6 months yet"; and *not very active* was defined as "Most weeks I don't get in 90 minutes of moderate or intense physical activity". "Moderate" and "intense" activity were not defined within the survey.

Respondents who marked "other" for activity level reported being consistently active for less than the last six months (e.g. "Consistently active for the last two months or so") or being extremely active ("90 minutes of activity a day") or inactive ("Practically none").

Activities that yielded affective benefits

Respondents reported getting affective benefits from a wide range of activities, including walking, hiking, running, climbing, classes at the gym, yoga, and others. While some of the experiences described involved breaking personal records or meeting personal goals, many involved simply going to the gym or for a walk, without it being an exceptional accomplishment.

As shown in Table 2, most of the experiences reported were routine events. Respondents reported having experienced affective benefits from exercise relatively frequently over the last 30 days ("Other events in the last 30 days").

Activities with affective benefits	n	%
Typicality of activity		
Routine	108	71%
Unusual	44	29%
Unusual how?*		
Context (e.g. location, time of day)	23	52%
Intensity or duration	21	48%
Type of activity	13	30%
Purpose of the activity	8	18%
Other	6	14%
Other events in the last 30 days		
0	3	2%
1-2	22	15%
3-5	40	26%
6-10	36	24%
More than 10	51	34%

Table 2. Characteristics of activities that yielded affective benefits. *Only asked when the event was marked 'unusual'.

Types of affective benefits

Respondents reported experiencing a relatively narrow range of affective benefits as a result of their exercise session. Responses were coded into several themes (see Table 3 for a frequency count by theme; note that many responses displayed multiple themes). Below we describe each theme and offer example descriptions from respondents. We also briefly describe the negative impacts respondents reported.

Affective benefits

Respondents reported feeling happy and proud as a result of their physical activity session. Many also expressed a sense of physical well-being, a sense of renewed energy, or a sense of peace or relative tranquility as a result of their exercise session.

Theme	n	%*
Types of affective benefits		
Happiness	83	54%
Pride	71	46%
Physical well-being	70	46%
Tranquility	44	29%
Reinvigoration	49	32%
Confidence	18	12%
Other affective benefits	21	14%
Causes of affective benefits		
Intrinsic enjoyment	47	31%
Intensity	12	8%
Company	24	16%
Time for myself	10	7%
Goal achievement	99	64%
Distance from other problems	23	15%
Concurrent stimuli	35	23%
Other causes	24	16%

Table 3. Frequency of types and causes of affective benefits. *Percent of total responses to the question

Happiness: Many respondents reported feeling happy as a result of the exercise session, like R266 who wrote that his hike made him feel "*Happy to be alive*". Some respondents reported feeling a general mood boost, like R107 who wrote that because of the experience they "*[f]elt positive about everything*".

Pride: Pride was the second-most frequent benefit reported. Respondents described feeling proud of themselves and their accomplishments, as when R68 wrote, "*It made me proud of myself for working really hard.*"

Physical well-being: Feeling physically good was another common theme. Respondents frequently wrote about feeling strong or healthy. At times respondents spoke vividly of how activity made them feel, as when R268 described how her class made her "*body move into another world of Happy*". Sometimes it took on a more specialized

meaning, as when exercise was respondents' means of pain management.

Tranquility: Many respondents reported feeling calmer or more peaceful as a result of their activity session. R280 illustrated this outcome in describing how taking a walk with her sister "*soothed my raw nerves from my job*". Similarly, R191 reported that the activity session made them feel "*more at ease and grounded*."

Reinvigoration: In some cases, respondents felt energized or more focused, like R148, who "*felt like I could tackle my whole 'to do' list*". This affective benefit sometimes co-occurred with 'Tranquility'. Some respondents elucidated this juxtaposition by explaining that their bodies felt more energetic while their mind felt relaxed, or vice versa, like R154, who wrote, *"…my mind was more relaxed. I had more energy*."

Confidence: Some respondents felt more confident as a result of their activity session. R232 reported feeling "*more confident*". Similarly, R132 said the event had "*definitely made me good about myself*".

Other affective benefits: Respondents reported feeling a few other affective benefits. R177 reported feeling "*connected*" after taking a dance class with her son. R38 expressed a sense of virtue, saying doing activity made him feel "*[l]ike I was treating my body correctly."* Similarly, R256 felt "*smug*" after reaching a goal. However, benefits like this did not occur frequently within the data set.

Negative impacts

Although the survey asked respondents only about the affective *benefits* of exercise, a few respondents reported negative impacts of exercise. However, no respondent reported a wholly negative experience. 24 respondents mentioned feeling tired or exhausted, but these comments were accompanied by a description of positive benefits like those described above. Of the 5 respondents who reported another negative impact, 2 were expressing annoyance at the leader of their exercise program, 1 was referring to the difficulty of warming up, and 1 was reporting feeling scared from doing a daring activity. Only 1 participant (R76) reported truly disliking exercise, and derived pleasure only from maintaining their health – their response is described in the following section.

Causes of affective benefits

Respondents were asked what about the experience had **caused** the affective benefits they felt. Responses were coded into several themes: intrinsic enjoyment, intensity, company, time for myself, goal achievement, distance from other problems, concurrent stimuli (i.e. some other element co-occurring with the activity), and 'other'. Many responses expressed more than one theme. Table 3 shows the frequency with which each theme occurred; Figure 1 shows the correlation between causes and affective benefits.

Intrinsic enjoyment: Intrinsic enjoyment of the activity itself contributed to affective benefits for some respondents. Respondents said they enjoyed the feeling of motion or something about the activity itself, like R27: *"being able to get my body moving and utilizing all my muscles made my body and mind happy."* Similarly, R13 enjoyed dance because of "*just the physical exertion and the ability to channel that into an art form"*.

Intensity: For some respondents, affective benefits came specifically from the intensity of the work. As one respondent said, "*The simple act of a strenuous physical activity makes me feel good*" (R21). Other respondents said what made them feel good was "*the feeling of fatigue*" (R83) and "*working [their] body to exhaustion*" (R53).

Company: Respondents frequently reported that the company they kept during their exercise session, or the lack thereof, contributed to the affective benefit of their experience. The nature of the company itself varied considerably between respondents, from the more intimate company of a spouse (e.g. R277) to a sports team working together (e.g. R55). Another respondent, R126, felt benefit just from "*seeing lots of other people out and about too*" on a run.

Time for myself: For other respondents, having time to themselves or doing something for themselves contributed to the affective benefit of activity. Several respondents liked "*having the chance to slow down, and be introspective*" (R09), having "*time to myself to think*" (R131), or "*being able to hide in a forest*" (R05). One respondent called the gym their "*sanctuary. I love being in a place where I don't know anyone…*" (R154) For some respondents, what mattered was not that they did the activity alone, but that they did the activity *for themselves.* For instance, R223 said that one thing that made them feel good was that their accomplishment at the gym "*was my own, no one else could claim it.*"

Goal achievement: Respondents were not asked about explicit exercise goals. However, many respondents described the causes of their good feelings in a way consistent with achieving a health goal, even if they did not refer to an explicit goal. These implicit health goals varied greatly, from generic health maintenance to sharpening sport-specific skills.

In some cases the goal achieved was to exercise at all: R169, for example, wrote, "*I like achieving goals, and exercise is a goal I achieved*." For respondents like R106, accomplishing exercise was a matter of "*check[ing] the activity off of my daily to do list*" – a matter of productivity rather than health. For respondents like R264, having exercise as a routine had a special meaning of recovery: "*I had surgery [a couple of months ago], so getting back to my normal routine was an accomplishment*."

Other respondents focused on progress within exercise, like R210 who had set a weightlifting goal and a timeline "*to hit*

those numbers by the end of the year," but felt "*amazing*" when she achieved them ahead of schedule. Similarly, R55 "*felt proud that my soccer skills were improving*". For some respondents the progress was less specific: for example, R41 wrote, "*I am proud that I have more strength, greater endurance, and better form than I did when I started."* A couple of respondents, like R75, even felt good because exercise helped them meet apparently unrelated health goals. He valued doing cardio workouts because when he did them he could "*sleep better at night.*"

Interestingly, respondents sometimes felt good even when they explicitly failed to meet a goal. For instance, R182 wrote:

"When I work out I have a competition with myself. I try to burn more calories each time I go.... while I didn't "beat " my high score I still did my best and walked away feeling great."-R182

Some participants seemed to have a general health maintenance goal that could be their only reason for exercising or could coexist with other goals. R114 juxtaposed a general health goal with aspirations for improving concrete skills:

"*Also, I assume I'm doing something for my long-term health and I know that definitely I'm improving my hiking, backpacking, and (most important) ability to play rough with grand kids..*" –R114

By contrast, R76 complained that during exercise they were "*Miserable at the time. I only feel good in general knowing that I am maintaining my health.*"

Distance from other problems: Affective benefits sometimes sprang from the ability to forget about other responsibilities for a while. As R55 described how "*stress and anxiety have been a big part of my life for several years...any chance to blow off steam and forget about all of that for a few hours makes me feel good.*" Similarly, R261 said their activity session "*helped me let go of some things that had been bothering me.*"

Concurrent stimuli: For some respondents, concurrent stimuli like the environment they were in or music they were listening to contributed to the experience of affective benefits. Some participants explicitly credited the environment, as when R71 said they felt good because of "*being in nature and hearing water, birds, insects, etc*." Another respondent, R175, credited the environment for all the affective benefit, saying, "*Physical activity doesn't normally make me feel notably better. But being outside in a beautiful place does. I feel better when I've done almost anything outside in a beautiful place, including ... running, walking, or hiking*." R192, in an urban environment, enjoyed "*seeing the city in a different way*". Other participants drew pleasure from engaging with thoughts or other material while exercising, like R171, who said, "*I like having a lengthy period of having to do nothing but listen to my podcasts and think of my stories.*" Similarly, R179 described "*running on a treadmill and reading Wikipedia articles….I learned all about the first four kings of France. It made me feel amazing and I barely felt the pain from running*."

Other causes: Most responses coded as 'other' were also coded with one of the above themes, but contained some element that did not occur frequently in the data set. For example, R266 attributed his positive feelings not just to the environment and company, but also to a sense of adventure: he enjoyed a hike because of *"[t]he views, the fresh mountain air, the feeling of exploring places [I]'ve never been before, traveling the road less traveled with the woman I love*". Other causes respondents named for their good feelings included endorphins or hormones, a sense of novelty or nostalgia, feeling attractive, and benefits to others. Several respondents, wise to the ways of physiology, credited biochemicals for their affective benefits. A couple of respondents felt good because of the novelty of the activity, like R192 who wrote "*the novelty of cycling made me feel good*". On the opposite end of the spectrum, R24 enjoyed swimming because of the nostalgia: "*Being in the water was a throwback to high school so it felt great*." A couple of respondents said they felt good partly because the activity session made them feel "*attractive*" (R188) or "*thinner*" (R144). Occasionally respondents attributed their good feelings to the knowledge that someone else was benefiting: for instance, R206 felt good partly from "*knowing my dog got a good walk*".

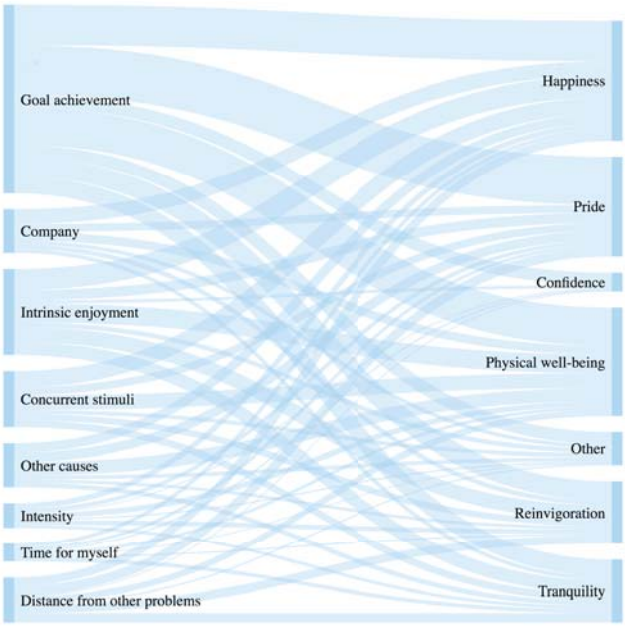

Figure 1. Sankey diagram showing co-occurrence between causes and affective benefits.

Relationships between causes and affective benefits

Overall, the affective benefits that participants experienced and the causes for those benefits were highly

interconnected. Co-occurrence of codes of causes and affective benefits are illustrated in Fig. 1. Although every cause is related to every benefit, these relationships are not equal: for instance, goal achievement is more tied to happiness and pride than to reinvigoration. We discuss the implications of this inequality in the Discussion section below.

Temporality of affective benefits

Respondents said they felt affective benefits during the activity, immediately after the activity, and looking back on it later. In addition, a few respondents (6 of the 'other' responses) said they felt good *before* the activity, in anticipation of it. Results are reported in Table 4.

When the affective benefits were experienced	n	%*
During the activity	110	72
Immediately after the activity	137	90
Looking back on it later	103	68
Other	8	5

Table 4. When respondents experienced affective benefits. *Percent of total responses to the question

Tracking and sharing of affective benefits

Overall, respondents reported that they did not track or log the affective benefits of their exercise session. However, almost half of all respondents said they shared information about affective benefits with others, even if they did not track or log it. Surprisingly, the most common ways of sharing affective benefits were in person or over text message. Results are reported in Table 5.

Tracking/sharing affective benefits	n	%*
Total who recorded any aspect of their activity session	**71**	**47%**
Total who recorded affective benefits	18	
Total who shared any aspect of their activity session	**105**	**69%**
Total who shared affective benefits	68	
In person	60	
Over text message	24	
Over Facebook	19	
Over the phone	16	
In other ways	28	

Table 5. Tracking and sharing of affective benefits. *Percent of total responses to the question

Impact on future activity

Survey respondents were asked if they planned to change anything about their exercise routine because of the experience they described. Results are presented in Tables 6 and 7.

Plan to make changes?	n	%*
Total planning to make changes:	**116**	**76%**
Do more of this kind of activity	90	
Push myself harder	65	
Add variety into my routine	21	
Do more activity at this location	21	
Do more activity at that time of day	15	
Do more activity with that group of people	15	
Do more activity alone	11	
Reschedule something else to accommodate my exercise better	13	
Share more about my activity with others	7	
Scale back my activity	2	
Other change	4	
No change	**36**	**24%**

Table 6. Changes to exercise routines that respondents intended to make. *Percent of total responses to the question

A majority of respondents did plan to make changes to their exercise routine based on their experience of affective benefits from physical activity. Moreover, most of the planned changes revolved around doing more physical activity. As shown in Table 6, most respondents who intended changes to their plans had also already executed those changes. This held true across activity levels.

Activity level	Intended to make change	Already made change
Consistently active	68	42
Inconsistently active	34	17
Not very active	10	5
Other activity level	4	2
Total:	**116**	**66**

Table 7. Respondents who had already executed changes to their exercise routines.

DISCUSSION

Our findings demonstrate that physical activity sessions that yielded affective benefits motivated people to make changes to their exercise plans that would result in

increased physical activity. Moreover, they shed light on the *reasons* those activity sessions made people feel good. Taken together, these findings elucidate the design space of affect-based physical activity interventions that can be explored in future HCI research. In this section we relate our findings to other literature that highlights the motivating force of affective benefits and the implications of our findings for affect-based physical activity interventions.

Exercise motivation and causes of affective benefits

Although our survey did not ask respondents about their motivations for their exercise session, a few respondents reported affective benefits as being the central reason they exercised. For instance, R149 said, "*I feel better every single time I've exercised. It's what motivates me to work out even when I don't want to.*"

These comments, as well as our finding that experience of affective benefits motivated increased future activity, echo other findings in exercise psychology about motivations for general or routine exercise. In particular, various exercise motivation scales use affective constructs to capture motivations for routine exercise. Some of these constructs are similar to themes in our findings. For instance, the revised Exercise Motivation Inventory (EMI-2) [19] includes items for "Stress management" that resemble our affective theme of "tranquility," and items for "revitalization" that echo some of the comments we classed as "reinvigoration".

However, exercise motivation scales like the EMI-2 measure motivation for exercise overall. Our analysis of the reasons people experience affective benefits from physical activity allow for the differentiation of the effects of individual activities or activity types on affect. The ability to distinguish the effects on a user's psyche of different activities opens up two new classes of interventions, described below.

Design implications for affect-based physical activity interventions

Our findings suggest that affect-based physical activity interventions are fertile new ground for behavior change research. In particular, our results point to two classes of interventions that leverage positive affect to encourage physical activity: (1) interventions that harness information about affective impacts to make recommendations about physical activities, and (2) interventions that manipulate users' existing physical activities in some way to enhance the affective impacts of physical activity.

As an example of type (1), systems could help people expand their repertoire of activities they find enjoyable. Systems that monitor the affective impact of exercise could detect which activities result in greater affective benefits or changes in affective benefits over time, and recommend different types of activities accordingly. Our findings on the reasons people experience affective benefits provide a starting point for understanding what aspects of activities different users enjoy. Future work to build a more comprehensive classification system could enable a smart system to use historical information about users' enjoyment of activities to recommend new ones. Smart systems could furthermore tailor their recommendations based on contextual information about the user, like their location, schedule, and local weather. For example, a system that knows that a user derives enjoyment from listening to podcasts during physical activity could suggest additional activities that still enable listening, or even quieter walking routes to enhance enjoyment of the experience.

As another example of (1), systems could use affective information as a framing technique to invite users to engage in physical activity. For example, a system that knows that users experience affective benefits from outdoor activities could lure users into physical activity with messages about fresh air, while users who derive affective benefits from the distance from other problems afforded by physical activity could receive messages about stress relief or leaving problems behind them. Systems could also leverage affective data as a contextual clue about when to suggest physical activity to users.

As an example of (2), affect-based systems could suggest ways to change an activity to make it more enjoyable. Our findings on the reasons people experience affective benefits provide a starting point for finding new ways to accomplish this goal. For instance, researchers could try improving the experience of a simple walk by suggesting that users chat with a friend (*company)*, walk in a new place or listen to an audiobook (*concurrent stimuli)*, or even practice mindful walking techniques (*intrinsic enjoyment)* as they go.

Our findings that routine events can yield affective benefits and that such exercise episodes occur frequently suggest that affect-based interventions can be deployed in daily life. Furthermore, our findings that people of all activity levels were motivated to increase their physical activity by the events they described suggests that affect-based interventions could be effective across broad swathes of the population.

Open questions for the representation of affective benefits

Our discussion thus far has focused on the value of our categorization of the reasons for affective benefits, rather than the categorization of the affective benefits themselves. Many scales exist for classifying affective states or even exercise-specific affective states: PANAS [29], the Exercise-Induced Feeling Inventory (EFI) [12], the Russell circumplex model [25], and others. Our categorization of affective benefits has some overlap with the EFI, which offers four categories of feelings that result from exercise (positive engagement, revitalization, physical exhaustion, and tranquility) [12], but distinguishes between feelings like pride and happiness, which the EFI does not.

The Russell grid [25] categorizes affective states along two dimensions: valence (positive or negative) and arousal.

AffectAura [21] made use of this model to visualize affective states, and PAM [24] offered an easy and reliable way to input data along a Russell grid, making it a desirable model of affect. Moreover, the Russell grid has the merit of capturing the widest range of affective states with the most parsimony [10]. This very parsimony, however, is a limitation: the Russell grid cannot reliably distinguish between anger and anxiety, which can both be of negative valence and high arousal. However, these two words represent very different emotions which may influence behavior in different ways [10].

The connections between causes and benefits shown in Fig. 1 show how this ambiguity could cause a problem for an affect-based system that relies on the Russell grid. Although the causes for and types of affective benefits were highly interrelated, they were not evenly so – for instance, goal achievement was more often connected with pride and happiness than with reinvigoration. However, on a Russell grid, happiness could be difficult to separate from reinvigoration. Given that causes are tied with greater or lower frequency to specific benefits, the question arises: is it important to distinguish specific affective benefits in an affect-based system? Or is the general capture of an affective state afforded by the Russell grid enough?

Our survey was not designed to suss out the importance of articulating different affective benefits for users, but this question could be very important for the design of an affect-based physical activity intervention. HCI interventions have explored many different ways of visualizing affective data (e.g. [21,27,28]), but none of these have been targeted at promoting physical activity. Many questions around how to represent affective data for this purpose remain unanswered. From the user perspective, is it more useful to reflect on data linking particular exercises to a feeling of excitement, or to a positive-valence, high-arousal state? Which is more meaningful or motivating to users, and how does that answer change when data must be aggregated and reflected on over time? More work is needed to understand how best to represent affective data to promote behavior change for physical activity.

Open questions for supporting sharing of affective benefits

Our findings about the tracking and sharing of affective benefits show that sharing with others how one felt after physical activity is relatively common. While our survey did not ask why or how people chose to share information, the relatively high rate with which people shared affective benefits (45% of respondents to the question and 65% of people who shared anything at all) suggests that sharing this type of information is a valuable interaction for many people. Yet such sharing was largely done in person rather than over technology. There are many reasons why this might be so. It could be that people chose to share information about affective benefits in person because it was difficult to do via digital systems; this could also explain why tracking of affective benefits was so much less common. Another possible explanation is that digital systems offer no incentive for recording or sharing information about affective benefits, making even a low entry bar not worth passing. Alternatively, respondents may not have seen the affective benefits of exercise as a relevant dimension to be tracked, but still found value in sharing the information with others. While our findings cannot answer these questions, they raise the possibility that technologies that make tracking and sharing of affective benefits easier could fit into individuals' existing habits of communication with family and friends, offering another source of value for continued engagement with the system. More work is needed to explore this possibility.

LIMITATIONS AND FUTURE WORK

Our survey represents a starting point for work on affect-based physical activity interventions. Our population is skewed towards younger and relatively active people located in the United States, and our analysis of the affective benefits people experience from physical activity, and especially of the causes for those affective benefits, is likely not comprehensive. More work will be needed to fully understand the dimensions that make activities enjoyable, as well as the user states that impact enjoyment (e.g. energy level prior to exercise, etc.). Our study likewise cannot attest to the impact of cultural factors on activity enjoyment, since our sample was heavily skewed towards residents of a single nation. Other factors besides enjoyment may also moderate activity selection in a way relevant for the types of interventions described above. For example, a system seeking to make smart activity recommendations may also need information about how much planning time or equipment is required. Identification of these dimensions, as well as the utilization of available contextual information about the user, will allow researchers to create systems that make smart and useful activity recommendations to users. Ultimately, expanding users' repertoire of enjoyable activities over time, and designing tools that emphasize the joy of exercise rather than the burden, can help users incorporate more physical activity into their lives.

CONCLUSION

The experience of affective benefits is a central component of exercise and could be a powerful motivator for change. More research must be done to understand how best to leverage the experience of affective benefits. However, our findings on the causes of enjoyment of physical activity provide a starting point. Information about the reasons why people enjoy exercise can be used to craft persuasive invitations to exercise or to recommend new forms of physical activity. Systems that capture information about the affective experience of exercise can also facilitate sharing of this information. Our findings illustrate the rich potential of this domain to motivate physical activity and an early sense of how to capture this information.

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