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The Psychophysiology of Contemporary Information Technologies

Tablets and Smartphones Can Be a Pain in the Neck[1]

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I had no idea that my breathing was affected and that my neck and shoulder tightened as I used my iPad. It was so cool to see my body's reaction when the experimenter reviewed the recording.

--J.L., 29 year old student

INTRODUCTION

The smartphone and iPad/tablet have revolutionized personal computing. iPad/tablets and smartphones can now do activities that until recently only computers could do such as e-mailing, browsing the internet, taking notes, playing games and connecting with social networks. This study explores 1) students use of smartphones and iPad/tablets measured with a survey questionnaire and 2) physiological patterns associated with smartphones and iPad/tablets use.

METHOD

Subjects

San Francisco State University students (n=105), ranging in age from 18-56 years old (mean=24.5, mode=21, sd=6.8) completed an assessment survey on the use of smartphones and iPad/tablets and 3 males and 3 females students ranging in age from 20-29 years old (mean=24, sd=3.09) were physiologically monitored while using their smartphones or iPad/tablets.

Equipment

Physiology was recorded with a Biograph ProComp Infinity (Thought Technology, Inc.). Two Myoscan Pro wide-placement electrodes were attached to the right and left upper trapezius muscles proximal to C4 with a reference electrode located on the spinous process. Two Myoscan Pro wide placement electrodes were attached to the lateral deltoid and teres minor/infraspinatous muscles of the participants' dominant shoulder proximal to the insertion with the humorous bone, with the reference electrode located half way between on the clavicle as shown in **Fig. 1**. All SEMG was recorded with the bandpass filter set between 100Hz and 200Hz. Thoracic and abdominal respiration was monitored using two strain gauges as shown in **Fig. 2**.

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Figure1. Neck and shoulder SEMG.

Figure 2. Thoracic and abdominal respiration strain gauges placements.

Procedure

Physiological recording

Each participant was recorded in standing and sitting positions while using their devices. Prior to the baseline test, the participants were asked to rate their neck and shoulder muscle tension and their overall energy level on a scale between 0-10. Measurements were recorded sequentially during relaxed pre-baseline, performing normal tasks on their devices, and relaxed post-baseline. The subjects repeated the same sequential procedure while sitting and standing. Then they completed a questionnaire rating their muscle tension and energy level.

Procedure: Survey Materials

Students filled out an online survey (Qualtrics, Inc.) which covered 1) Basic Info, 2) Smartphone use, 3) iPad use, and 4) Smartphone and iPad use.

RESULTS

Physiological Recording

During a naturalistic observation of smartphone and iPad/tablet users, there was

- Increased and sustained muscle tension in the neck and dominant shoulder of both smartphone and iPad users.
    - SEMG shoulder tension among iPad/tablet users was nearly double during the sitting task and triple during the standing task as compared to smartphone users and increased muscle tension of the shoulder was observed during the standing sequence for both smartphone and iPad/tablet users as compared to the sitting sequence (**Fig. 3**).
    - SEMG variability was reduced in the dominant shoulder of smartphone users during both tasks as compared to iPad/tablet users (**Fig. 4**).
    - SEMG neck tension increased of iPad/tablet users during both tasks (**Fig. 5).**
- Increased respiration rates were observed when using the devices during sitting and standing.
    - Respiration rates were 27% higher among iPad/tablet users as compared to smartphone users during the standing task (24 breaths/minute versus 17 breaths/minute) (**Fig. 6**)
    - iPad/tablet users experienced the highest respiration rates during the standing task whereas smartphone users experienced the highest breathing rates during the sitting task.
- There was no correlation between the subjective experience of tension and increased SEMG activity during smartphone use. The participants were unaware of the muscle tension and increase in breathing rates.
- There was a positive correlation between the subjective experience of tension and increased EMG activity during iPad/tablet use; however, they were unaware of their increased breathing rates.

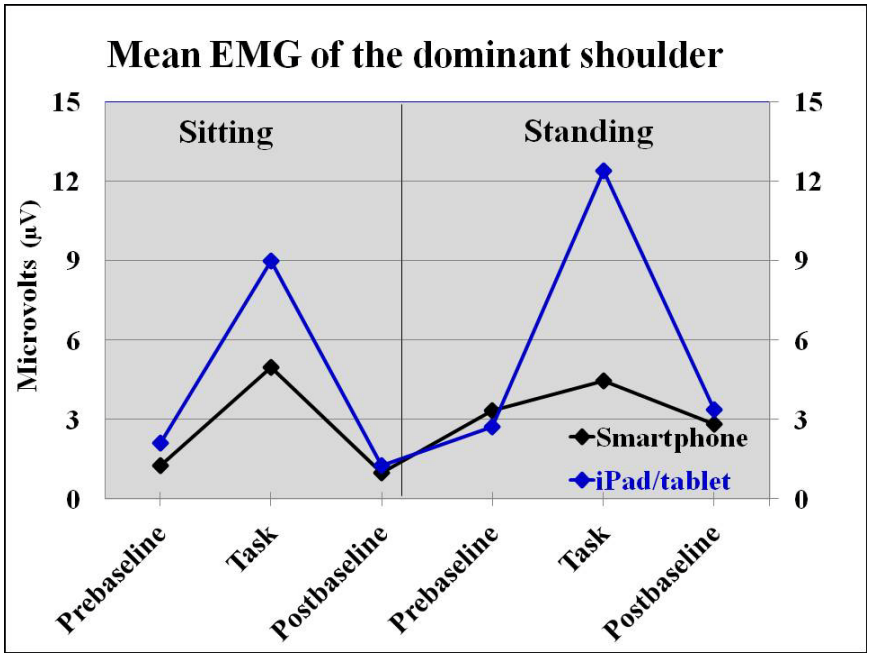

Figure 3. Dominant SEMG shoulder activity during smartphone and iPad/tablet use.

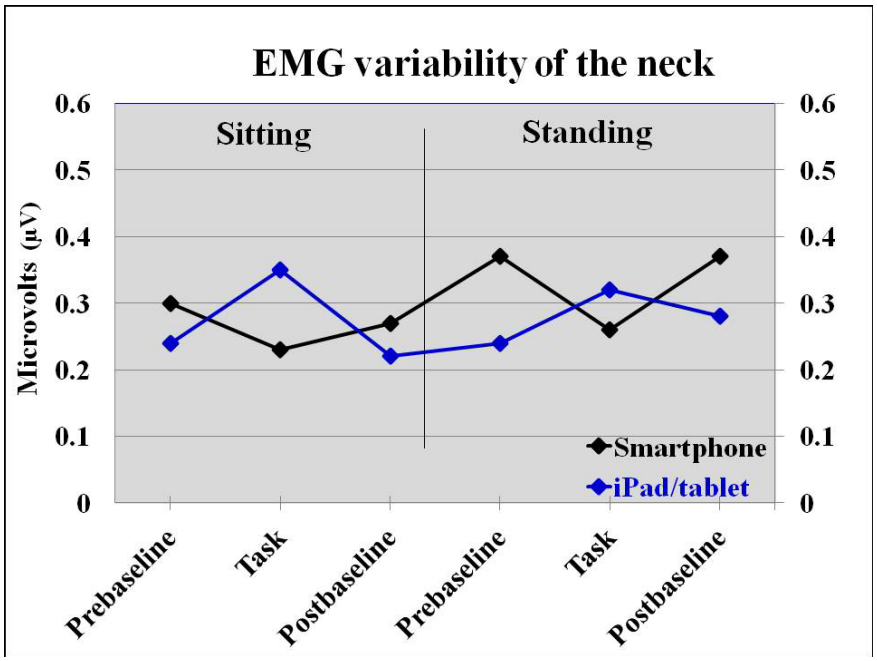

Figure 4. Dominant SEMG shoulder muscle variability during smartphone and iPad/tablet use.

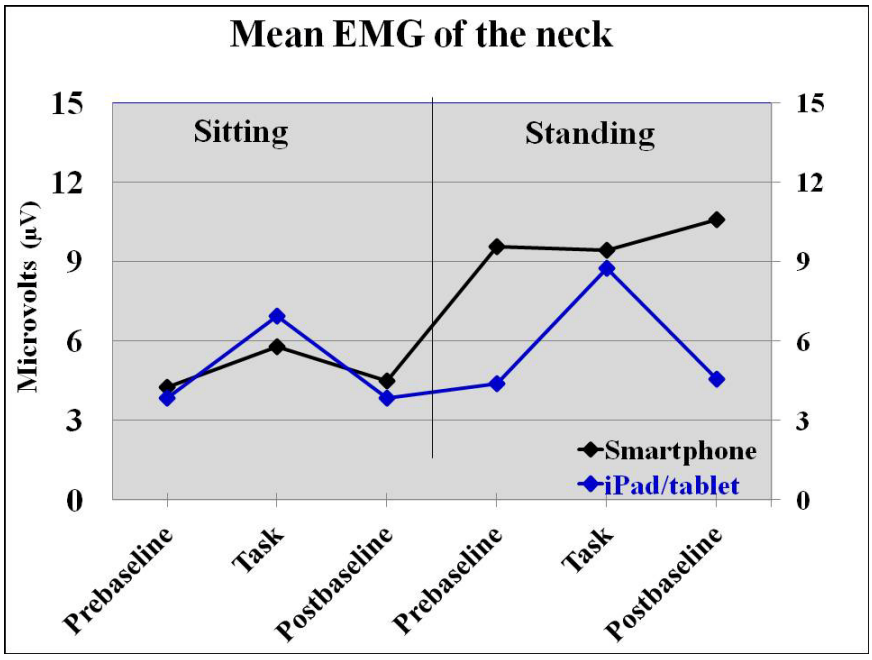

Figure 5. SEMG neck muscle tension during smartphone and iPad/tablet use

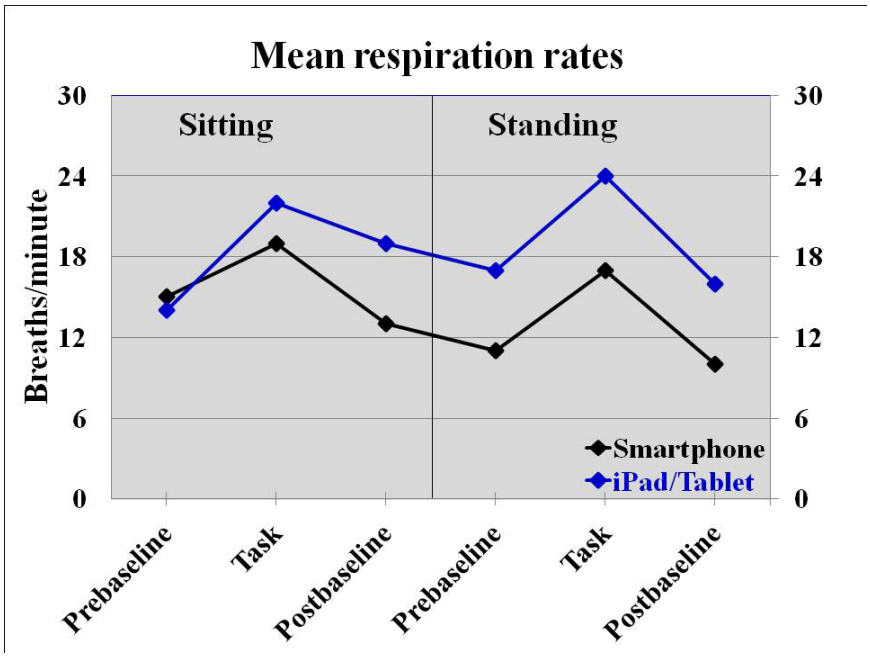

Figure 6. Respiration rates during smartphone and iPad/tablet use.

Survey Data

- Almost all students have smartphones and more than 80% having these devices for more than one year.
- 86% of iPad users also have smartphones (n=33).
- Many students experienced discomfort as is shown in **Fig. 7** and the symptoms associated with the eyes, neck, and shoulders are shown in **Fig. 8.**
- Students who used their smartphones for more than one hour reported significantly more eye, neck and shoulder symptoms than those who used their smartphones for less than one hour.
- Students use their smartphone or iPad/tablet one third of their time just before going to sleep. Smartphone users averaged a total of 118 min a day time use (78 minutes during the day (n=87) and an additional 40 minutes just before going to sleep (n=90). They also reported disturbed sleep as shown in **Fig.9 and 10**. **This means that students spent 19.7 days a year on their smartphones.**
- Texting while waiting in line was the number one activity among smartphone users while searching/browsing the internet was the number one activity among iPad/tablet users (**Fig. 11**)

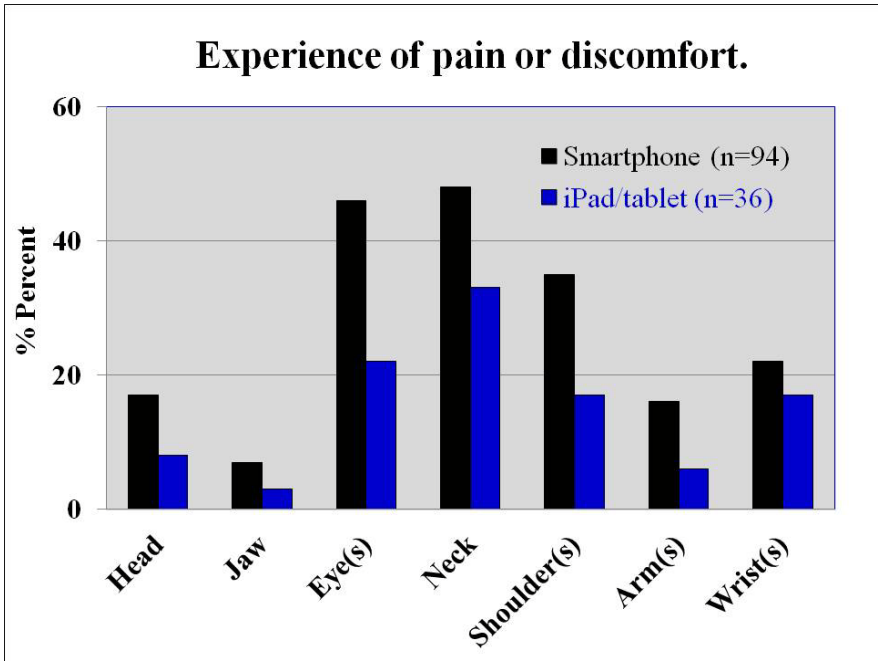

Figure 7. Distribution of body symptoms that students report when using smartphones and iPad/tablets.

	Eyes	Neck	Shoulders
Smart phone	• Symptoms 51% straining 49% dryness 27% burning Intensity: 3-4/10 (n=41)	• Symptoms 66% tightness 48% aching 47% soreness • Intensity: 3-5/10 (n=44)	• Symptoms 69% tightness 53% soreness 34% aching • Intensity: 5-7/10 (n=32)
iPad/ tablet	• Symptoms 57 % aching, burning, dullness Intensity: 3-4/10 (n=7)	• Symptoms 86% soreness 71% tightness 57% aching Intensity: 4-5/10 (n=7)	• Symptoms 71% cramping, tightness 43% aching, soreness • Intensity: 3-5/10 (n=6)

Figure 8. Specific symptoms and intensities associated with smartphone and iPad/tablet use.

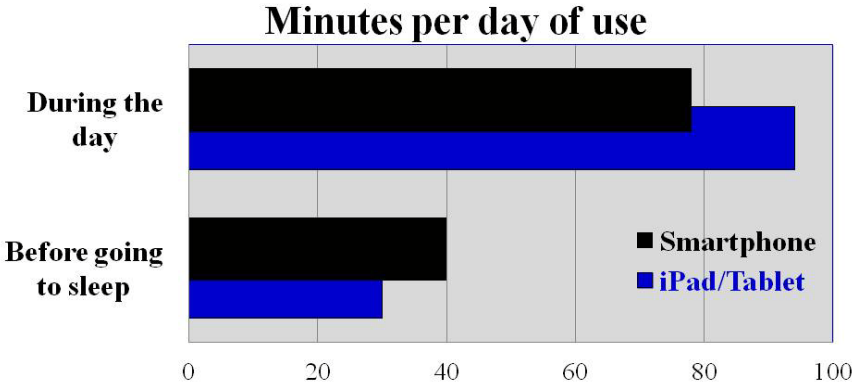

Figure 9. Minutes of smartphone and iPad/tablet use during the day and before going to sleep.

	Experience Disturbed Sleep	Average Amount of Sleep/night
Smartphone	47% yes (n=34)	6.7 hours (n=33)
iPad/Tablet	50% yes (n=38)	6.9 hours (n=36)

Figure 10. Amount of sleep and experiences of disturbed sleep of smartphone and iPad/tablet users.

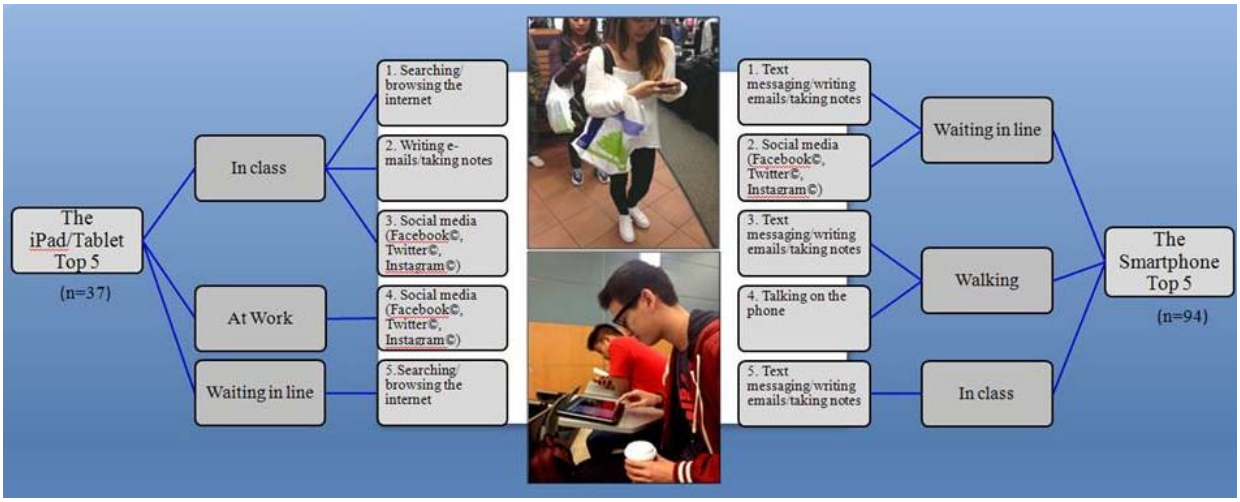

Figure 11. Smartphone and iPad/tablet use.

DISCUSSION

Smartphones and iPads/tablets are highly integrated into students' lives and at the same time the students are unaware how these new technologies may affect their health. Even though many report discomfort and sleep disturbances, none of the students were aware that their breathing patterns were affected. There were similarities and differences in the physiology and use of the smartphone and iPad/tablet during naturalistic observations. Shallow and quickened breathing patterns coupled with increased sustained muscle tension in the neck and dominant shoulder were observed in smartphone and iPad/tablet users.

The major difference in SEMG activity during smart phone versus tablet use appeared to be due to the weight and size of the device. **Smartphones with their small screens demands that the person freezes in place, being braced and stabilized.** In comparison, tablet use allows the person hand and arm movements. **The shoulder tension was significantly higher for tablet use because they tended to extend their arms and hands forward while during smartphone use the person tended to bend their neck.**

As researchers, we worry about the future cost to the individual of constants smart phone and iPad/tablet use. The average use is increasing and these devices are being used in addition to daily laptop use by college students and workers alike. **Going from a hunched over posture while using a computer to intermittent hunched over postures using a smartphone and/or iPad/tablet further immobilizes the body and increases the risk of stress immobilization syndrome. The health implications include increased risk musculoskeletal disorders, repetitive strain injury (commonly manifested as carpal tunnel syndrome, thoracic outlook syndrome), dry eyes syndrome, and backache.**

We expect that the chronic dysponetic posture—collapsed and breathing shallowly--will lead to an increasing epidemic of musculoskeletal disorders. Moreover, the hunched over body posture may in the long term contribute to the increasing epidemic of exhaustion and depression.

RECOMMENDATIONS

The findings are disturbing and from a public health perspective demand that preventative educational strategies are instituted. We recommend the following when using these devices:

- Take many breaks –drop your shoulders, straighten up, look around, wiggle and move.
- Incorporate more physical activity during the day and after each smartphone or iPad/tablet use.
- Practice slower breathing to counter the shallow rapid breathing that may contribute to hyperventilation.
- Arrange iPad/tablets ergonomically in order reduced dysfunctional body postures.
- Set up time management procedure for smart phone and tablet use.
- Do not use self-illuminating devices (smartphones/iPads/tablets, laptops, monitors, etc) an hour before sleep.

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