

The Trackpad™ – A Study on User Comfort and Performance

POSTER

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ABSTRACT

The user study on the TrackPad™, a new touch tablet technology input device, was designed to investigate the impact of the use of the device on the biomechanical load and postural comfort of the users. In a one day test, the subjects, experienced Macintosh users, performed tests and worked on tasks, using a portable computer, that were organized to resemble normal office tasks and measure performance. The tasks included intensive use of the keyboard.

The performance was measured by text editing tasks and eight Fitts's Tests with two levels of difficulty. The biomechanical load was measured and evaluated by means of EMG and postural (motion) analyses. General comfort and postural comfort was evaluated with questionnaires.

The analyses of the EMG-measurements yielded no indication of progressive fatigue or increased muscular load from one session to the next. On the contrary, the recorded EMG-levels showed a decrease in muscular activity. The postural analyses indicated that undue deviation, extension, or flexion of the hands, which may cause discomfort, generally did not occur. The average values were within the limits given by the physiology of the human arm. However, personal preferences for the arm posture were highly different.

When performing the text editing task with the TrackPad™, during the training session, the subjects had already achieved a performance equivalent to 65% of mouse performance. A performance of more than 90% was achieved after two hours and 100% in the fifth hour session. This means that the learning period for such tasks will in practice be accomplished within one working day. The average performance achieved with the TrackPad™ for the eight tasks with Fitts's Test, during the last session, was lower than that with the mouse, but the difference was not statistically significant.

The results of this study indicate that the TrackPad™ can be used for everyday tasks without causing postural discomfort or fatigue. In some respects, this device may even be preferable to the mouse, if the users can achieve the same level of performance.

KEYWORDS: Input device, TrackPad™, postural discomfort, EMG

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CONTENTS OF THE POSTER

The poster serves discussing following items:

- The objectives of the study
- The questions the research work should help answering
- The methods used
- The test procedure
- Main results of the research work.

In addition, some of the important results are represented for discussion.

THE OBJECTIVES OF THE STUDY

Performance and precision

Although the main focus of the study was postural comfort and biomechanical load, the level of performance and precision the subjects achieved under test conditions is of importance since an input device has to be task adequate.

Biomechanical load

The assessment of the biomechanical load of the arm muscles is needed to evaluate the likelihood of causing discomfort or strain.

General comfort

The impact of the use of the device on general comfort (e.g. self-reported fatigue or stress) is a good indicator for effects that cannot be assessed by measuring the biomechanical load.

Postural discomfort

Postural discomfort at different parts of the body is another good indicator for the overall impact of the use of the device on the subjects.

METHODS

Performance Test

The performance was measured by a text editing task and eight Fitts's Test with two levels of task difficulty corresponding to the intended use of the TrackPad™. The results were compared with those achieved with a mouse, a device for which the average experience of the subjects was longer than 3 years.

EMG-measurements

For part of the assessment of the biomechanical load, EMG-measurements of the muscles involved in the operation of the TrackPad™ were performed.

Posture analysis

The posture of the arm and the hand (pronation, ulnar deviation etc.) was assessed using video recordings.

Questionnaires

The subjects evaluated their general comfort, postural comfort, and stress/strain with questionnaires which had been tested in various studies.

QUESTIONS TO ANSWER

The study was designed to answer following questions:

- Is the device suitable for the tasks for which the specific computer was designed?
- Is there undue biomechanical load associated with the use of the device?
- Are there indications that the use of the device is associated with fatigue?
- Is postural discomfort affected negatively if the device and the computer are used for normal office tasks?
- Are there indications for undue stress?

MAIN RESULTS**Performance (Speed and Errors)**

When performing the text editing task with the TrackPad™, during the training session, the subjects had already achieved a performance equivalent to 65% of mouse performance. A performance of more than 90% after about two hours and 100% in the fifth hour session. This means that the learning period for such tasks will in practice be accomplished within one working day. This was the most encouraging outcome of the test since this test task resembled the most important use of the device.

In the Fitts's Test, the errors of the subjects occurred only sporadically and could therefore not be analysed. Since this was true for the entire test from the training session until the end, the performance of the subjects with respect to accuracy was at an adequate level in all sessions.

With regard to speed, the performance was direction dependent. The average performance over all eight tasks during the final session was lower than that with the mouse, but the difference was not statistically significant. However, the performance in the vertical direction (moving the cursor on a vertical line) remained remarkably low after five hours of testing (less than 80% of mouse performance). This means that the learning period for pointing tasks will be longer than one day if the same level as with the mouse is to be achieved.

Surprisingly, the difference of TrackPad™ to mouse performance was smaller for the tasks which had a higher level of difficulty. Both the subjects and the experimenters tended to underestimate the level of precision that was achieved with the TrackPad™.

Postural Comfort and General Comfort

It is believed that prolonged working with constrained postures is likely to cause postural discomfort or fatigue. The degree to which unfavorable effects occur after a certain time period depends upon how inconvenient the posture is. Recent research has demonstrated that within a four hour test period, of performing computer tasks, levels of discomfort increase even for those parts of the body not involved with the operation of the specific device [2].

Both direct ratings of postural comfort (wrists, forearms, back region) and ratings of fatigue and related symptoms (e.g. headaches, back aches, neck aches) gave no indication of discomfort or fatigue related symptoms after five hours of work. In comparison to a four hour keyboard test, conducted under similar conditions, the results obtained from the questionnaires of the TrackPad™ study were significantly better. Instead of increasing, most indicators for postural discomfort showed a decrease.

Biomechanical load

The analyses of the EMG-measurements yielded no indication for progressive fatigue or increased muscular load from one session to the next. On the contrary, the recorded levels showed a decrease in muscular activity. This may have been caused partly by learning effects. Surprisingly, the impact of the task difficulty on the muscular load was not significant.

The postural analyses indicated that undue deviation, extension, or flexion of the hands, which may cause discomfort, generally did not occur. The average values were within the limits supported by the physiology of the human arm. However, personal preferences of arm posture were substantially different. Thus, some users may perceive discomfort due to the hand position they choose. This is not a design flaw but simply a matter of user education

Interestingly, the hand deviation (bending the wrist towards the little finger) of the subjects using the mouse was greater than those using the TrackPad™ (18° versus 11.3°). The average hand deviation angle with the mouse was almost the same as in a recent Swedish study (18° versus 17.6°, [1]). From this point of view, the TrackPad even seems to be preferable to the mouse.

DISCUSSION

The results of this study indicate that the TrackPad™ can be used for everyday computing input tasks without causing postural discomfort or fatigue. In some respects, this device may even be preferable to the mouse, if the users can achieve the same level of performance. With respect to the levels of accuracy required during the test, a sufficiently high performance of the subjects was observed from the beginning.

For some tasks, it only took the subjects five hours to become as proficient with the TrackPad™ as that achieved with the mouse after many years of mouse experience. Given the fact that the test was not designed to exploit the features of the software for optimal learning progression, this is a very positive indication. In practice, the users can select the appropriate control/display ratio to their preference and change it as they become more proficient

For other tasks, the learning period may be longer than one day. However, it should be kept in mind that users of other input devices also need a lengthy period of familiarization that may even last longer than observed in this test.

In this study, the TrackPad™ was not tested for tasks which require very high accuracy (e.g. CAD-tasks, manipulation of graphics etc.). The reason for this was the manufacturer's intention of utilizing the device for a portable computer. Provided that further studies confirm our assumption that even higher levels of accuracy can be achieved, the TrackPad™ can be utilized in different types of devices to the benefit of the users, especially in work environments with space constraints.

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