

**EFFECT OF NBC PROTECTIVE GLOVES ON MANUAL
PERFORMANCE AND DEXTERITY**
LABORATORY AND OPERATIONAL COMPARATIVE TESTS

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INTRODUCTION

Through operational ergonomics experimentation conducted under extreme situations, the degradation of manual performance due to the wearing of NBC gloves is demonstrated. Nobody can be sure that the perfect glove could be designed (3). Nevertheless, taking into account new technologies used for the improvement of modern NBC permeable suits studies of a new generation of NBC gloves are ongoing. The present study had the following double objective:

- to measure the loss of performance on physiological parameters such as manual dexterity and tactile sensibility, for soldiers equipped with different types of NBC protective gloves (in-service or prototypes).
- to evaluate and validate a psychophysical method to measure the variations of tactile sensibility.

METHODS

Several tests were carried out on a series of volunteer military subjects. They used successively under a random sequence: an in-service glove compared with a charcoal foam layer covered with a leather glove, a prototype built with charcoal cloth, textile outerlayer and leather palm. The performances reached with these different types of gloves were compared with those obtained with the naked hand in two successive situations:

- in a laboratory setup (15 subjects): The subjects executed tests on tactile vibrometer (global sensibility index on 7 frequencies) and standardised NATO tests (2) Minnesota, O'Connor, Washer tests
- in a field study setup with a combat group from the Infantry Laboratory (10 subjects).

A rather exhaustive series of technical actions was processed during some operational activities (handling of weapons, radio and optical equipment). This experiment allows on one hand to verify, in an environment representative of an operational activity, that the level of degradation of manual performance observed in the laboratory is the same as the one observed in the field and on the other hand to evaluate the effect of this degradation on the operational capacity of a combat group.

The statistical interpretation of the results was by ANOVA. When effects were found by ANOVA, two by two comparisons between gloves were performed by the Fisher LSD method.

RESULTS

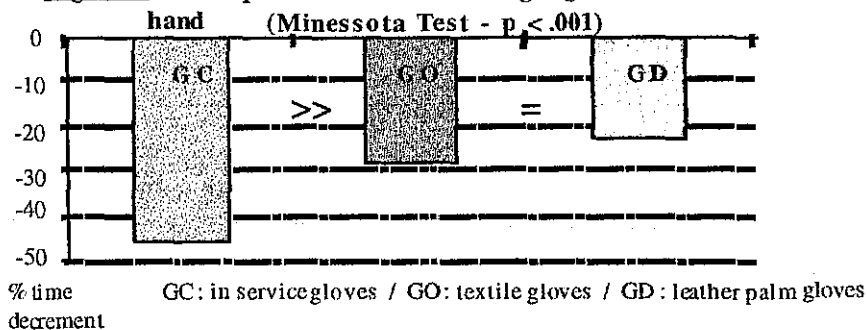
The results of the tactile sensibility test are given with reference to the naked hand. A global index usually used to evaluate tactile sensibility loss in ill people was calculated for each type of glove. Table 1 presents the results obtained for all subjects and the associated statistical level. Results show a non-statistically significant difference between naked hand and leather palm glove modalities. Tactile decrease was significant with the other gloves.

In service gloves	loss 1.5 db (significant at 95 %)
Textile gloves	loss 2.0 db (significant at 99 %)
Leather palm gloves	loss 0.8 db (non significant with reference to the naked hand)

The results of the NATO TEST show differences of time for the realization of the tests with the different gloves in comparison with the naked hand.

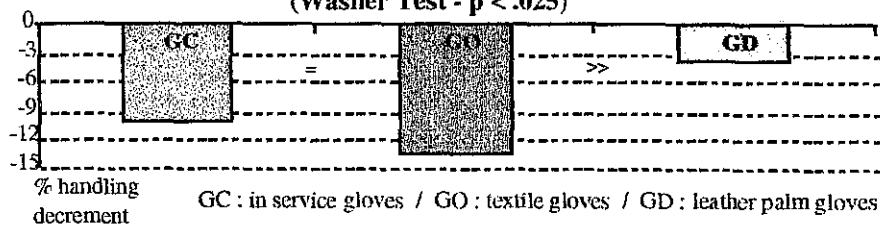
Figure 1 shows the effect of each tested glove on the time performance to realize the Minnesota test. Clearly, we can see differences for the time to perform the test for all the gloves in comparison with naked hands. The GC time decrement is more significant than the other two that are not statistically different.

Figure 1: Time performance decreasing : gloves versus naked



Differences between gloves are not the same from one test to another. The analysis of handling performance is well evidenced by the Washer test as presented in Figure 2. Handling decrement corresponds to mistakes or non realized actions during the test. The difference from the naked hand is less important than for the time criterion. The textile glove is the worst due to the specific characteristics of the external material mainly in taking thin objects.

Figure 2 : Handling performance decreasing : gloves versus naked hand
(Washer Test - $p < .025$)



The results obtained in the field study give the same classification of performance between the different types of gloves.

Finally in all cases GD and naked hand scores are the closest even in the tactile sensibility test. An excellent consistency was found between this test and the Washer test. Tactile variations can be tested with a tactile vibrometer which permits the choice of specifically adapted materials to design the glove.

CONCLUSION

The degradation in hand performance is very important with classical NBC protection gloves. The present prototypes open some interesting ways for new

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