Amsterdam University of Applied Sciences

The physical competence test of the Dutch National Police

the effects of wearing a police uniform on test performance

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The physical competence test of the Dutch National Police: The effects of wearing a police uniform on test performance

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ABSTRACT

In this study, we investigated the effects of wearing a police uniform and gear on officers' performance during the Physical Competence Test (PCT) of the Dutch National Police. In a counterbalanced within-subjects design, twenty-seven police officers performed the PCT twice, once wearing sportswear and once wearing a police uniform. The results showed clear indications that wearing a police uniform influenced the performance on the PCT. Participants were on average 14 seconds slower in a police uniform than in sportswear. Furthermore, performing the test in uniform was accompanied by higher RPE-scores and total physiological load. It seems that wearing a police uniform during the test diminishes the discrepancy between physical fitness needed to pass the simulated police tasks in the PCT and the job-specific physical fitness that is required during daily police work. This suggests that wearing a police uniform during the test will increase the representativeness of the testing environment for the work field.

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Police uniform; physical fitness; representative testing; test performance; job-specificity

1. Introduction

Police officers must be able to react quickly to emergency situations during their work. When police officers are, for example, on foot patrol, they may need to change rapidly from walking at a slow pace to sprinting to arrest a robber or wrestle a suspect to the ground. Such situations are characterized by adequate and fast reactions requiring good physical fitness. To be able to assess whether police officers are sufficiently physically prepared for daily police work, it is relevant to test their physical fitness (Caspersen, Powell, & Christenson, 1985; Mol & de Vries, 2007).

The value of physical fitness of police officers depends on the degree to which it can be applied in realistic situations (Anderson, Plecas, & Segger, 2001). To examine physical fitness in a relevant and valid manner, the testing environment must be representative for the work field (criterion environment; Staller, Zaiser, & Körner, 2017), and therefore contain relevant practical skills, constraints, and competencies needed on duty. This means that a valid test for police officers should entail how strength, endurance, and mobility are characterized during police work, and discriminate between officers who are strong, fit and able enough for police work, and those who are not.

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Police departments worldwide strive for physical competence tests that are strongly related to the actual requirements of the job (e.g., Kratcoski, 2004; Rajakaruna, Henry, Cutler, & Fairman, 2017). Despite these efforts, there is scope for improvement to increase job-specificity and representativeness of these physical tests (e.g., Handcock & Dempsey, 2011; Lonsway, 2003). For example, police officers often report that the competencies and fitness required in physical tests are only moderately applicable on duty (e.g., Bissett, Bissett, & Snell, 2012; Renden, Nieuwenhuys, Savelsbergh, & Oudejans, 2015). The findings in this study may offer a relatively simple way to improve the fidelity of physical competence tests, and diminish the discrepancy between physical fitness needed to pass a physical competence test and job-specific physical fitness required during daily police work.

The Dutch National Police uses the Physical Competence Test (PCT) to measure job-specific fitness. Yet, the execution of the PCT could possibly be improved. A comprehensive evaluation report of the PCT, commissioned by the Dutch Ministry of Security and Justice, suggests that wearing a police uniform during the test could contribute to job-specificity of the PCT (Straatmeijer, Visee, & Collard, 2017).

Interestingly, it seems to be the current universal practice to test officers in sportswear instead of a police uniform, for example, in the Job Related Fitness Test (JFRT) in England and Wales (Brown, 2007), and Physical Abilities Requirement Evaluation (PARE) in the Canada (Anderson et al., 2001). The PARE was revalidated to investigate to what extent the test constitutes an accurate simulation of physical actions and responses required by the job (Anderson & Plecas, 2007, 2008). The possible influence of wearing a police uniform, however, was not included in the revalidation process. Therefore, the current study aimed to provide insight into whether wearing a police uniform during test execution should be included in test protocols. This might be especially relevant for police departments that strive for high fidelity and validity of their physical tests. Using a sample of Dutch police officers, the main aim of this study was to investigate the influence of wearing a police uniform on performance using the PCT. Police officers completed the PCT twice, once in sportswear and once in police uniform. In a counterbalanced within-subject design, the two conditions were compared regarding time, perceived exertion (RPE), and physiological strain.

1.1 The physical competence test (PCT)

The PCT is an obstacle course set up in a gym hall that all operational police officers have been required to pass annually since 2012. To pass the PCT, police officers have to meet the time standard that applies to their gender and age. For example, the time limit in the age category 25–29 years is 190 seconds for men and 226 seconds for women. In the age category 50–54 years, these time limits increase to 218 seconds and 305 seconds, respectively. Currently, no consequences are in place when officers fail to complete the PCT within the standards set. In some cases, however, supervisors review results to make an action plan if the employee is not fit enough (Straatmeijer et al., 2017).

Police officers have to perform various physical tasks that represent tasks that police officers may encounter on duty, such as running, moving over obstacles and transferring (heavy) objects. The PCT is based on the Physical Abilities Requirement Evaluation (PARE) test, which was used as a selection tool at the Canadian Police Academy (Anderson et al., 2001). Development of the PCT started with research into the daily working activities and the minimum demands on physical fitness of the Dutch Police (Mol & Visser, 2002, 2004), which resulted in a Competence-Based Physical Test for Dutch Police officers (Mol & de Vries, 2007). In 2010, Strating, Bakker, Dijkstra, Lemmink, and Groothoff presented the next step to further develop the PCT. They analyzed gender-and-age dependent differences and to what extent the test measured the ability to perform essential police tasks (Strating, Bakker, Dijkstra, Lemmink, & Groothoff, 2010). They stated that the PCT simulates three important police tasks: chase (running), physical control (move over and transport) and evacuations (carrying). The PCT is a well-standardized test that has been evaluated and validated several times (Strating & Bakker, 2008; Strating et al., 2010).

1.2 Testing in uniform

Police officers currently perform the PCT in sportswear, such as gym shorts, T-Shirts, and athletic shoes; whereas, the uniform of the Dutch police consists of a safety-vest, heavy shoes, strengthened pants and a belt with various necessities, such as a handgun, pepper spray and a baton. In contrast, the physical fitness test of Dutch firefighters is performed while wearing full firefighting equipment (Plat, Frings-Dresen, & Sluiter, 2011). Taylor, Lewis, Notley, and Peoples (2012) showed that firefighters' performance on a job-related obstacle course decreased by 27% when wearing full equipment. Furthermore, research on the effects of wearing specialized body armor in the military has revealed negative effects on balance, strength, speed, mobility and physiological strain (e.g., Daanen & Koerhuis, 2003; Park et al., 2013; Tomes, Orr, & Pope, 2017). Dempsey, Handcock, and Rehrer (2013) were the first to investigate whether wearing a complete police uniform influenced job-specific task elements. Overall performance decreased significantly; physiological costs (%HRmax, %VO2max,) and perceived exertion (RPE) were greater when wearing stab-resistant body armor and accessories, compared to unloaded armor. Dempsey et al. (2013) concluded that this finding could indicate impaired functioning during job-specific skills, such as lower mobility during maneuvering tasks and slower acceleration during sprint tasks.

In daily police work, job-specific skills and physical fitness are not separate entities, but in combination, they shape job-specific fitness (Anderson, Litzenberger, & Plecas, 2002). The aim of the PCT is to test job-specific fitness. It is therefore questionable that an element that influences physiological costs and task execution, that is, wearing a police uniform, is not included in the test. Straatmeijer et al. (2017) stated that incorporation of the police uniform in the PCT is primarily set aside due to the lack of explicit knowledge of a possible increased risk of injuries. However, in line with the aforementioned studies, this may cause invalid measurement of job-specific fitness. Because police officers are allowed to perform the PCT in sportswear, a possible discrepancy may exist between the necessary physical fitness to pass the PCT and the fitness needed to function well as a police officer in the field.

2. Methods

2.1 Participants

Twenty-seven participants performed the PCT twice. This group of participants consisted of 21 men and six women, with a mean age of 38.27 years (SD = 8.92). All participants were regular police officers that had to take their annual physical fitness test. All participants were asked to complete an anamnesis form. If this form showed any health problems, participants were excluded from this experiment. Participants provided informed consent and before the start of this study, ethical approval was obtained from the university Scientific and Ethical Review Board (VCWE-2017–037).

2.2 The physical competence test

The PCT is an obstacle course that is performed in a gym hall and consists of five rounds with several sub-parts. The sub-parts are defined as elements where participants have to move over an obstacle or transfer (heavy) objects. For example, participants move over a vaulting box with a height of 150 cm and push a handcart of 200 kg. In each round, police officers have to run from sub-part to sub-part and then return to the starting point to start the next round. This means that performance-wise it takes time to run between the sub-parts and it takes time to do the sub-parts. Not every sub-part is performed in each round. Table 1 shows which rounds contain which sub-parts. An overview of the PCT is presented in Figure 1.

Table 1. Sub-parts per round of the PCT.

Rounds	Sub-parts
Round 1, 3 & 5	– Moving over a vaulting box in broad direction – Moving over Swedish gymnastic benches – Pushing a handcart of 200 kg for 6 m – Moving three medicine balls weighing 5 kg
Round 2 & 4	– Moving over a vaulting box in broad direction – Moving over Swedish gymnastic benches – Pulling a handcart of 200 kg for 6 m – Moving over a vaulting box (length) in longitudinal direction
During the entire test: Running 226.5m (between the sub-parts)	

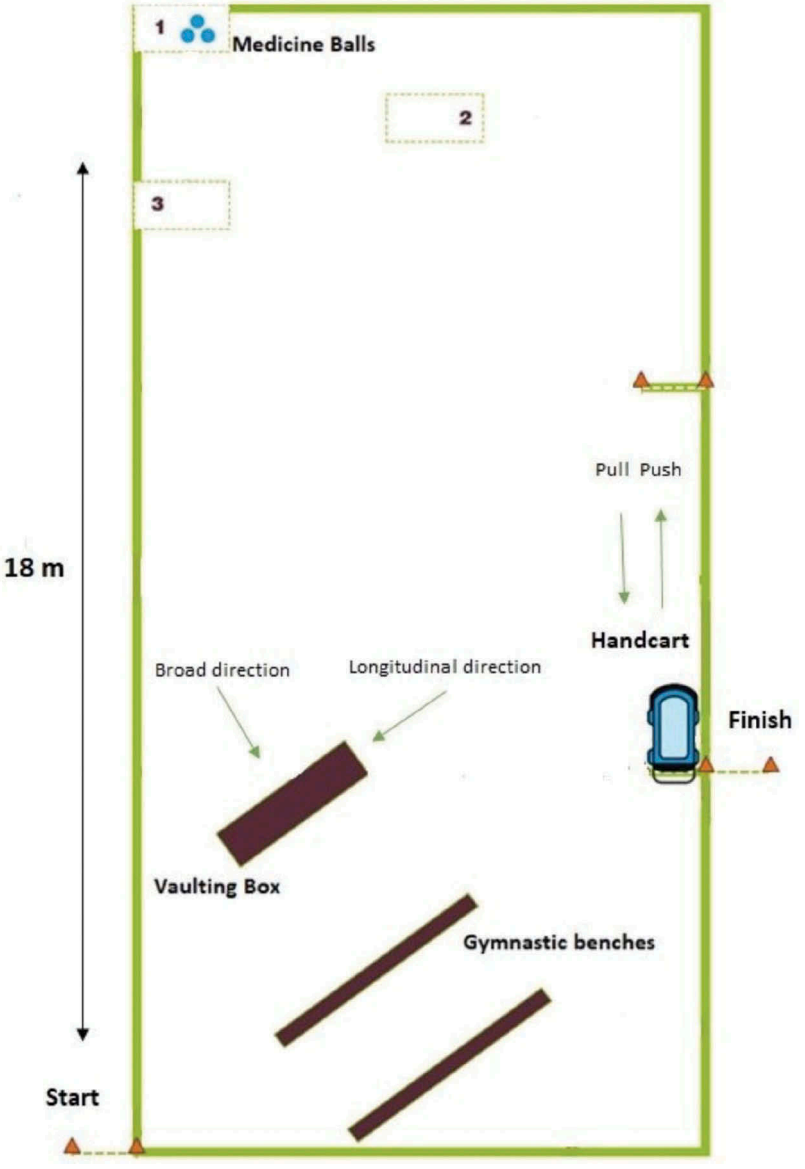

Figure 1. A top view of the course of the PCT including the sub-parts.

2.3 Design

A 2 (clothing: police uniform/sportswear) x 5 (round: Round 1–5) within-subjects design was applied. The participants completed the PCT twice on the same day, one-time wearing sportswear, and one-time wearing a police uniform. The resting period between the two attempts was on average two hours, with a minimum of 30 minutes to ensure participants returned back to a resting state. The factor clothing (sportswear and police uniform) was counterbalanced: half of the participants completed the course in sportswear first, and the police uniform next, while the other half wore a police uniform first, and sportswear next. The dependent variables used to compare results were the times participants took to complete elements of the test, ratings of perceived exertion (RPE), measured with a Borg-scale, and physiological intensity and physiological load, determined using heart rate measures.

2.4 Clothing

In the sportswear condition, participants wore a t-shirt, short pants, and athletic footwear. In the police uniform condition, participants wore a polo shirt with short sleeves, safety vest, strengthened pants, armored shoes, and a belt with a loaded bluegun (training weapon), handcuffs and pepper spray. Participants did not wear a baton for reasons of safety. The difference in total weight between the sportswear condition and the police uniform condition was about 9.4 kg. Figure 2 shows a participant in sportswear and in police uniform.

2.5 Measurements

We measured the time participants needed to complete the entire course, each round, each sub-part, and total time between sub-parts (running and walking). Video recordings (GoPro Hero 3) were used for the time recording. The camera was positioned to film the entire PCT course. The time to complete different rounds and sub-parts was calculated by counting frame numbers in the videos, which were analyzed with WinAnalyze software (Version 2.1.1, Mikromak, Berlin, Germany). To define the start and stop points of the sub-parts we used markers on the ground. The total time between sub-parts was determined by subtracting the time on the sub-parts from the total time of the whole test.

A Borg Rating of Perceived Exertion Scale was used to determine participants' ratings of perceived exertion (RPE) (Borg, 1998). The scale ranges from 6 (*very light*) to 20 (*very hard*). Participants actively indicated their RPE-score by marking their score on a hard copy scale immediately after both tests.

Physiological parameters were measured using Zephyr PSM (Zephyr Technology Corporation, Annapolis, MD, US). This is a physiological monitoring device that was strapped to the participants' chest. The Zephyr PSM has demonstrated good accuracy in heart rate and respiratory rate measurements during exercise compared to a validated laboratory metabolic system, with correlations of ≥.90 (Kim, Roberge, Powell, Shafer, & Jon Williams, 2012). For analysis, the corresponding Omnisense software of the Zephyr was used.

The Zephyr PSM measured two physiological parameters: (1) the physiological intensity, and (2) the physiological load. In the Zephyr Technology Corporation (2016), the physiological intensity is defined by the % of subjects' HRmax and converted to a 0–10 scale. The null-value on this scale is equivalent to 50% HRmax or less. The participant is then considered to be resting. Running will increase this percentage above the 50% level. The ten-value on the scale is equivalent to 100% HRmax. The participant is then considered to be making a maximum effort (Zephyr Technology Corporation, 2016).

The physiological load is defined as an accumulated sum of the physiological intensity values (Zephyr Technology Corporation, 2016). Maximum Heart Rate of participants was estimated using the 220-age formula (Astrand & Ryhming, 1954). The formulas for calculating physiological intensity and load are presented in Appendix A.

Figure 2. Female participant in sportswear (t-shirt, short pants, and athletic footwear) and police uniform (strengthened pants, armored shoes, safety vest and a belt with handcuffs). The loaded bluegun and pepper spray, which participants also wore in their belt during testing, are not displayed in this figure.

2.6 Analysis

To determine the effect of clothing on total times and RPE, we performed two paired samples *t*-tests. Additional paired samples *t*-tests were conducted to determine the differences between sportswear and police uniform for times on the sub-parts and between the sub-parts.

Times per round and per sub-part were analyzed using 2 (clothing) x 3 or 2 (rounds) ANOVAs. Because there is a difference in length between Round 1, 3 and 5 and Round 2 and 4, we conducted both 2 (clothing) x 3 (rounds [1, 3 & 5]) and 2 (clothing) x 2 (rounds [2 & 4]) ANOVAs. Not all sub-parts were present in every round of the PCT, so for every sub-part, we ran the ANOVA with the correct number of rounds. Table 1 shows the sub-parts that were executed in each round.

To determine the effect of clothing on the physiological intensity and load, two paired samples *t*-tests were performed to compare average intensity and total load of the entire test when participants wore sportswear and when they wore the police uniform. Physiological intensity and load per round were analyzed using 2 (clothing) x 5 (rounds) ANOVAs.

ANOVAs were followed by relevant post hoc Bonferroni comparisons to identify where the specific differences occurred among the rounds. Bonferroni corrections were used to examine the interaction

effect if significant. These corrections were also used to calculate the 95% CI for each difference between the means.

The assumption of sphericity was checked using Girden's (1992) criteria. If the Greenhouse-Geisser epsilon ≥ 0.75, the Huynh-Feldt correction was used, otherwise the Greenhouse-Geisser correction was used. The assumption of normality was checked by visual inspection of the q-q plot and the box plot of the data within the groups. A Shapiro–Wilks test was also performed on the data. There were no violations of these assumptions.

3. Results

Participants' time and physiological variables are presented in Tables 2 and 3.

These tables show the mean values and mean differences between the police uniform and sportswear condition.

3.1 Total time

The paired samples *t*-test for total time revealed that participants were on average 14 seconds slower, 95% CI [−16.94, −11.14], when they wore the police uniform compared to when they wore sportswear, $t(26) = -9.92$, $p < .001$.

Table 2. Average times when wearing sportswear and police uniform (SDs in parentheses).

	Sportswear	Police uniform	Mean differences (sportswear-police uniform)
Total time	181.18 (19.14)	195.23 (20.34)	−14.05***
• Between sub-parts	66.01 (6.17)	71.01 (5.96)	−5.00***
• On sub-parts	115.17(13.76)	124.13(15.31)	−8.95***
Round 1	42.10 (4.46)	44.13 (4.25)	−2.03**
Round 2	24.40 (2.51)	26.43 (3.06)	−2.03***
Round 3	45.59 (5.36)	48.99 (5.24)	−3.39***
Round 4	25.10 (3.06)	27.79 (3.41)	−2.69***
Round 5	44.09 (4.86)	47.77 (5.72)	−3.69***
Vaulting Box	2.76 (0.11)	3.16 (0.12)	−0.40***
Swedish gymnastic benches	1.46 (0.03)	1.55 (0.02)	−0.09***
Handcart Push	4.42 (0.09)	4.53 (0.09)	−0.11
Medicine Balls	20.54 (0.48)	21.96 (0.51)	−1.42***
Handcart Pull	5.60 (0.13)	5.81 (0.13)	−0.21*
Vaulting box length	3.99 (0.14)	4.72 (0.13)	−0.73***

*p < .05, **p < .01, ***p < .001. All means are reported in seconds(s).

Table 3. RPE scores, average physiological intensity (% of subjects' HRmax and converted to a 0–10 scale) and cumulative physiological load (accumulated sum of the physiological intensity values) comparing sportswear and police uniform (SDs in parentheses).

	Sportswear	Police uniform	Mean differences (sportswear-police uniform)
RPE	12.33 (1.14)	14.44 (1.74)	−2.11***
Average intensity			
Full test	8.65 (0.68)	8.70 (0.88)	−0.05
Round 1	6.70 (0.30)	7.34 (0.25)	−0.64
Round 2	8.75 (0.16)	8.79 (0.17)	−0.04
Round 3	9.22 (0.12)	9.19 (0.16)	0.03
Round 4	9.32 (0.11)	9.42 (0.13)	−0.10
Round 5	9.46 (0.11)	9.52 (0.11)	−0.06
Cumulative load			
Full test	26.28 (3.36)	28.83 (4.18)	−2.55***
Round 1	4.69 (0.23)	5.30 (0.21)	−0.61*
Round 2	8.37 (0.31)	9.22 (0.33)	−0.85*
Round 3	15.45 (0.43)	16.85 (0.54)	−1.40**
Round 4	19.42 (0.52)	21.25 (0.67)	−1.84**
Round 5	26.28 (0.70)	28.83 (0.87)	−2.55***

*p < .05, **p < .01, ***p < .001.

3.2 Round times

The 2 (clothing) x 3 (round [1, 3 & 5]) ANOVA revealed significant main effects of clothing, $F(1, 26) = 81.59$, $p < .001$ and round, $F(1.5, 38{,}6) = 49.98$, $p < .001$. There was also a significant interaction between clothing and round, $F(2, 52) = 3.59$, $p < .05$.

The 2 (clothing) x 2 (round [2 & 4]) ANOVA revealed significant main effects for clothing $F(1, 26) = 72.34$, $p < .001$, and round, $F(1, 26) = 20.14$, $p < .001$. There was also a significant interaction effect between clothing and round, $F(1, 26) = 4.14$, $p < .05$.

Post-hoc Bonferroni comparisons revealed that participants were slower in every round in police uniform compared to sportswear ($p < .01$). Nevertheless, the time differences increased during the rounds. This suggests that the participants became gradually slower in police uniform as the rounds increased (see Table 2).

3.3 Sub-parts

The 2 (clothing) x 5 (round) ANOVAs revealed significant main effects of clothing and round on the *vaulting box,* $F(1, 26) = 29.44$, $p < .001$, and $F(2.8, 82.8) = 19.85$, $p < .001$, respectively, and the *Swedish gymnastic benches,* $F(1, 26) = 21.35$, $p < .001$, and $F(2.6, 67.2) = 8.53$, $p < .001$, respectively.

The 2 (clothing) x 3 (round) ANOVAs revealed no significant main effect of clothing on the *handcart push,* $F(1, 26) = 2.48$, $p = .127$, but it did for round, $F(1.7, 43.2) = 16.90$, $p < .001$. For the *medicine balls*, there was a significant main effect for both clothing, $F(1, 26) = 83.76$, $p < .001$, and round, $F(1.4, 37.6) = 25.20$, $p < .001$.

The 2 (clothing) x 2 (round) ANOVAs revealed a significant main effect of clothing for the *vaulting box length,* $F(1, 26) = 44.0$, $p < .001$, but no significant main effect of round, $F(1, 26) = 1.27$, $p = .271$. For the *handcart pull*, there was a significant main effect for both clothing, $F(1{,}26) = 4.82$, $p < .05$, and round, $F(1.26) = 10.96$, $p < .01$.

The results indicate that when officers wore their police uniform they were significantly slower on the sub-parts than when they wore their sportswear. The ANOVAs on the sub-parts revealed no interactions (Fs < 2.56, ps > .05) between clothing and round, indicating that the effect of the police uniform remained similar for the sub-parts during the rounds. This means that the effects of the police uniform on the sub-parts were similar in the first rounds of the test compared to the later rounds.

3.4 Time on sub-parts and time between sub-parts

The significant difference in total time between the sportswear and police uniform conditions consists of differences in (running) time between sub-parts and time performing the sub-parts. A paired samples t-test revealed that participants ran 5 seconds slower when running in police uniform, $t(26) = -8.54$, $p < .001$. For the total sub-part times, the participants were 9 seconds slower in police uniform than in sportswear, $t(26) = -8.63$, $p < .001$. The results imply that the differences in total times come both from running between the sub-parts and from performing the sub-parts. Participants had comparable time loss during running relative to the subparts; participants were around 8% slower in both running and performing sub-parts when wearing a police uniform.

3.5 Rating of perceived exertion

The paired samples t-test for RPE revealed that participants indicated a higher perceived exertion after completing the PCT in a police uniform, $t(26) = -7.71$, $p < .001$. Overall, the RPE was around two points higher in police uniform than in sportswear, 95% CI [−2.67,-1.54]. This indicates that participants experienced more exertion in police uniform than sportswear (see Table 3).

3.6 Physiological intensity and cumulative physiological load

The paired samples *t*-test for average physiological intensity during the test revealed that the physiological intensity while wearing police uniform did not differ significantly from the physiological intensity when wearing sportswear, $t(23) = -0.24$, $p = .815$ (see Table 3). Yet, the total physiological load of the test was significantly higher after wearing the police uniform compared to sportswear $t(23) = -11.32$, $p < .001$.

3.6.1 Physiological intensity per round

The 2 (clothing) x 5 (round) ANOVA revealed no significant main effect of clothing on the physiological intensity, $F(1, 23) = 1.46$, $p = .24$, but it did for round, $F(1.3, 29.6) = 139.51$, $p < .001$. There was also a significant interaction between clothing and round, $F(1.3, 29.6) = 4.98$, $p < .05$. Post-hoc Bonferroni comparisons revealed that there was no significant difference in physiological intensity in every round comparing police uniform to sportswear. However, note that the difference in physiological intensity in Round 1, although not significant, is observably larger comparing to the other rounds (Figure 3, Table 3), explaining the significant interaction. From Round 2, the physiological intensity with police uniform is almost equal to that in the sportswear condition.

3.6.2 Physiological load per round

The 2 (clothing) x 5 (round) ANOVA revealed a significant main effect of clothing, $F(1, 22) = 16.03$, $p = .001$, and round, $F(1.0, 23.4) = 1186.44$, $p < .001$, on the physiological load. There was a significant interaction effect for physiological load between clothing and round, $F(1.3, 29.5) = 4.28$, $p < .05$. Post-hoc Bonferroni comparisons revealed that in every round the physiological load was higher in police uniform compared to sportswear ($p < .01$). The differences, however, increased over the rounds. After Round 1, the physiological load in police uniform was 0.61 points higher compared to sportswear. After Round 5, the physiological load in police uniform was further increased to 2.55 points higher than in sportswear (see Figure 4, Table 3).

4. Discussion

In this study, we investigated time to completion and physiological effects of wearing a police uniform on officers' performance during the Physical Competence Test (PCT) of the Dutch National Police. The results showed that participants were on average 14 seconds slower when they wore a police uniform than when they wore sportswear. Officers were slower in every round of the test and lost relatively the same time running between sub-parts compared to performing

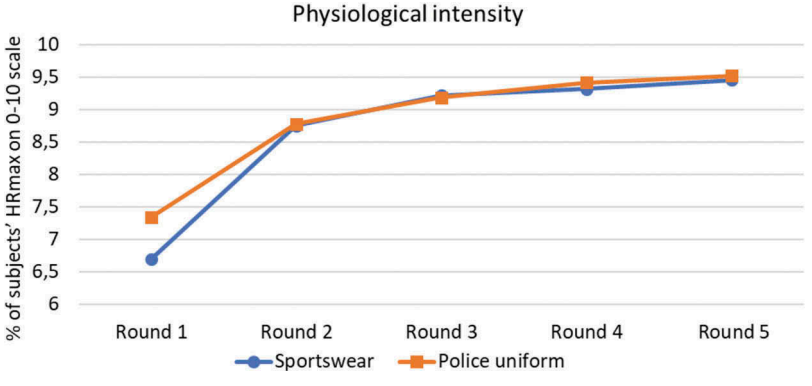

Figure 3. Average physiological intensity per round defined as % of subjects' HRmax and converted to a 0–10 scale.

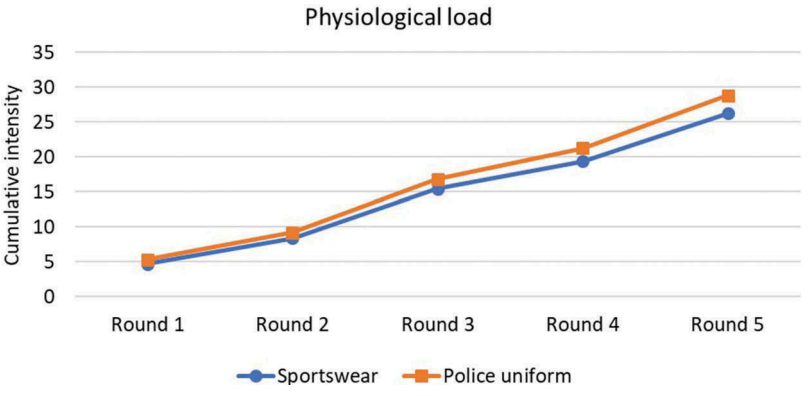

Figure 4. Cumulative physiological load per round. This figure illustrates the physiological load defined as an accumulated sum of the physiological intensity values.

the sub-parts. For every sub-part, participants were significantly slower when they wore their police uniform than when they wore sportswear, except for the handcart push. The fact that wearing a police uniform did not lead to slower execution of the handcart push may be explained by the fact that participants did not have to maneuver their body weight in counteracting direction (Jung, Haight, & Freivalds, 2004).

The physiological intensity during the test did not differ significantly between police uniform and sportswear conditions. Nevertheless, the interaction effect between condition and rounds provides a better understanding of the effect of the police uniform on the participants' performance during the PCT. With the uniform, participants' intensity tended to be higher in the first round of the test. After Round 2, the intensity values with uniform on a certain round were on the same level of the intensity values in sportswear at that same round (see Figure 3). This suggests that participants lowered their pace after Round 1 due to the extra load of the police uniform. The fact that the physiological intensity in the sub-parts remained equal during the entire test indicates that the pacing was primarily applied between the sub-parts, that is, running. The explanation for the pacing strategy is supported by the ratings of perceived exertion. Several studies have demonstrated that when the RPE reaches maximal levels, athletes reduce the work rate to protect the body against elevated body temperatures or depleted glycogen concentration (e.g., Nielsen, Hyldig, Bidstrup, Gonzalez-Alonso, & Christoffersen, 2001; Nybo & Nielsen, 2001). This indicates that the perceived exertion is an important mediator of pacing strategies during self-paced practice (Tucker, 2009) and a potential cause for the slower overall time on the PCT in police uniform.

Despite the applied pacing strategy, the perceived exertion in police uniform was still two points higher than in sportswear. Because the physiological intensity remained almost similar from Round 2, the participants presumably built up a higher physiological load due to increasing round times and the longer duration of the complete test when wearing a police uniform. Hence, they indicated a higher perceived exertion. For instance, Tucker (2009) stated that when participants noticed in the first part of an exercise that the intensity was higher than expected, they reported a higher perceived exertion for the total exercise. Participants maintained this feeling of higher exertion, despite adjusting their pace in the second part of the exercise. It should be noted, however, that participants in the current study perceived just a moderate load when they wore their police uniform (RPE: M = 14.44). This could be the result of lowering their pace. Another explanation could be that participants were used to wearing the uniform because they were required to wear it constantly on duty (Carbone, Carlton, Stierli, & Orr, 2014). In any case, it may suggest that participants found that the execution of the PCT in police uniform was still feasible, and did not require much extra physical exertion.

Overall, we conclude that wearing a police uniform clearly influenced the performance on the PCT. Implementation of a police uniform when performing the PCT seems to contribute to a relevant and valid examination of job-specific fitness. Dempsey et al. (2013) stated that wearing a police uniform with accessories reduced mobility during tasks where participants had to maneuver their body weight. For example, moving over a vaulting box in police uniform including a belt with necessaries may feel different due to limited mobility and requires a different movement execution. Participants have to apply greater effort to overcome the inertia and initiate the movement because of reduced upper body mobility and increased external weight (Stubbs, David, Woods, & Beards, 2008).

Besides reduced mobility and extra external weight, the police uniform may also have thermo-physiological effects. Daanen and Koerhuis (2003) showed that body temperature increased by 0.3°C when wearing full protection gear caused by limited heat loss. Body temperature was not monitored during our study; however, participants in our study stated that they experienced heat strain and discomfort because of the stab proof safety vest. Several studies demonstrated that wearing protective clothing increased the risk of heat strain and caused discomfort because of impeding evaporation and convective heat loss leading to increased physiological strain (e.g., Cheuvront, Goodman, Kenefick, Montain, & Sawka, 2008; Wickwire et al., 2007).

Practically, the results in this study provide empirical support for performance decreasing effects of a police uniform. A relevant question is whether it is practically of interest to implement the police uniform in the execution of the PCT. It is expected that the PCT provides insight into the physical skills needed to perform job-specific tasks (Mol & Visser, 2002, 2004; Strating et al., 2010). Straatmeijer et al. (2017) argued that the extent to which the PCT achieves this goal is limited due to the insufficient one-to-one correlation between passing the test and performing well in actual police work, resulting in lower motivation and participation of employees. In this study, we show that the police uniform may be successfully implemented in the regular PCT execution. Most elements of the police uniform and gear (i.e., pepper spray, handcuffs, bluegun) were worn in the uniform condition, except for the baton that was not included for reasons of safety. The incorporation of the police uniform (and where possible, gear) therefore seems an appropriate and essential way to increase representativeness of the test for actual police work.

Nevertheless, the current universal practice is to test officers in sportswear instead of a police uniform. Our findings support that the effects of wearing a police uniform should not be underestimated in the test execution, if police departments worldwide strive for high fidelity and validity of their physical tests. We established previously that the issue of wearing a police uniform applies to international testing. However, how the findings in this study relate to implications they might have internationally needs to be discussed. First, the effects of a police uniform seem to apply to different test characteristics. Besides the effects in an obstacle course as the PCT, Dempsey et al. (2013, 2014) showed increased imbalance, slower acceleration, lower mobility, and reduced jump height during a balance task, sprint simulation, grappling task, and jumping task, respectively. Carlton, Carbone, Stierli, and Orr (2014) support these findings showing that Australian police officers were significantly slower during tactical movement and dummy drag tasks when wearing a police uniform. This suggests that wearing a police uniform is relevant for many different testing protocols in police departments worldwide. Secondly, in line with our results, preliminary research showed that RPE increases significantly when wearing a police uniform or body armor (e.g., Larsen, Netto, & Aisbett, 2011; Majchrzycka, Brochocka, Łuczak, & Łężak, 2013; Ricciardi, Deuster, & Talbot, 2007). In most police departments, police officers are required to wear the police uniform on duty and are therefore used to wearing the uniform. This may imply that the subjective load during test protocols corresponds to what they can experience on duty. However, it seems important here that police departments acknowledge the importance of also wearing a police uniform during training sessions (Carbone et al., 2014). Thirdly, Anderson et al. (2007) asked Canadian police officers if there were any physical elements related to their job that they would like to see added to their annual physical test. The most mentioned addition was wearing a complete police uniform (uniform, vest, duty belt) to experience

physical fitness that applies to be on duty. Thus, besides training a sufficient number of hours, it may be more practical for police officers to present their own physical fitness in police uniform.

The incorporation of a police uniform in physical testing may also lead to resistance in police departments, for instance, because of organizational adjustments and possibly higher injury risk (Straatmeijer et al., 2017). Future studies should examine the long-term effects of execution of the PCT in uniform and focus on the following two relevant factors:

(1) Several studies have found that exercise in body armor increased the chance of injuries due to an increased ground reaction force (GRF) (e.g., Dempsey, Handcock, & Rehrer, 2014; Orr, Pope, Johnston, & Coyle, 2014; Park et al., 2013). Yet, research on the influence of a police uniform on injury prevalence is still limited. Our results did not include mechanical variables and GRF-analysis. Further research is needed to determine the mechanical influences of wearing a police uniform. Research objectives regarding acceleration and peak impacts will provide more knowledge about the mobility and task execution (e.g., landing mechanics, balance) on the sub-parts in the PCT and therefore information about the risk of injuries.
(2) Evaluation of the current time standards is needed. This study provides a first step in knowledge about the effects of wearing a police uniform during the test but does not include a balanced population for a thorough standard-setting process. First, we could not rule out that relatively fit and motivated police officers participated in this study because less fit officers are less inclined to execute the PCT twice on the same day. The police uniform may have a greater impact on less fit officers implying that the current study may actually underestimate the effects of the uniform. Secondly, in our study, we did not include gender-and-age related differences. Wearing a police uniform can possibly enlarge or shift the differences in gender and age (Blacker, Wilkinson, Rayson, & Richmond, 2014). For example, Taylor et al. (2012) found that the addition of extra load due to equipment imposed a greater relative burden for smaller and less-strong individuals, which were primarily women and older people rather than larger and heavier individuals (i.e., men and young people). Police departments can consider using small, medium, and large tailored vests for both men and women with different body shapes. For example, a smaller woman does not need a large vest; as a consequence, the plate in the vest and hence the weight of the vest can be smaller (Schram, Hinton, Orr, Pope, & Norris, 2018). To provide insight into exact effects, further data collection with a larger, well-balanced population is necessary.

5. Conclusion

In this study, it is demonstrated that wearing a police uniform influenced performance on the PCT. Participants were significantly slower in police uniform than in sportswear. The slower times were accompanied by higher RPE scores and higher physiological loads, possibly caused by lower mobility, extra weight, and heat strain. Our findings indicate that wearing a police uniform during the PCT will ensure that physical fitness to pass the PCT is more representative of the required physical fitness during tasks on duty. Policy implications of this study indicate that the police uniform: (a) can be successfully implemented in physical testing, (b) clearly influenced the performance of police officers, and (c) contributes to a relevant and valid examination of job-specific fitness. As such wearing an uniform provides an (easy) example of how police departments worldwide can improve fidelity of their physical tests. Thus, the question arises why police departments are still hesitant to add police uniforms to their physical testing protocols. Apparently, police departments focus on the persistent tension between having sufficient body protection versus decreased physical performance and increased physiological and subjective stress on duty (Larsen et al., 2011; Tomes et al., 2017). Next to attempting to resolve this prevalent issue, one way to move forward would be to include the police

uniform in the test environment so that the effects of the police uniform are already taken into account when assessing whether police officers are fit for work. In this way, police departments have a more representative reflection of their police officers fitness, but are also able to detect early implications of the police uniform on performance. For safe and adequate implementation of the police uniform in the test execution (a) further studies should investigate possible effects on injury prevalence, (b) new instructions and test protocols are needed, and (c) new (time) standards should be determined.

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References

Anderson, G. S., Litzenberger, R., & Plecas, D. B. (2002). Physical evidence of police officer stress. *Policing*, *25*, 399–420.

Anderson, G. S., & Plecas, D. (2007). *PARE task analysis. RCMP learning and development webpage*. Ottawa, ON: Retrieved from RCMP internal Learning and Development intranet web page archives.
Anderson, G. S., & Plecas, D. (2008). *Police abilities testing: Revalidation of the task analysis*. Ottawa, ON: RCMP Learning and Development Archives.
Anderson, G. S., Plecas, D., & Segger, T. (2001). Police officer physical ability testing – Re- validating a selection criterion. *Policing*, *24*, 8–31.
Astrand, P. O., & Ryhming, I. (1954). A nomogram for calculation of aerobic capacity (physical fitness) from pulse rate during sub-maximal work. *Journal of Applied Physiology*, *7*, 218–221.
Bissett, D., Bissett, J., & Snell, C. (2012). Physical agility tests and fitness standards: perceptions of law enforcement officers. *Police Practice and Research*, *13*, 208–223.
Blacker, S., Wilkinson, D., Rayson, M., & Richmond, V. (2014). Letter to the editor: The gender-neutral timed obstacle course: A valid test of police fitness? *Occupational Medicine*, *64*, 391–392.
Borg. (1998). Borg's perceived exertion and pain scales. *Human Kinetics*, *23*, 23–26.
Brown, J. (2007). From cult of masculinity to smart macho: gender perspectives on police occupational culture. In *Police occupational culture* (pp. 205–226). Oxford: Elsevier.
Carbone, P. D., Carlton, S. D., Stierli, M., & Orr, R. M. (2014). The impact of load carriage on the marksmanship of the tactical police officer: a pilot study. *Journal of Australian Strength and Conditioning*, *22*, 50–57.
Carlton, S. D., Carbone, P. D., Stierli, M., & Orr, R. M. (2014). The impact of occupational load carriage on the mobility of the tactical police officer. *Journal of Australian Strength and Conditioning*, *21*, 32–37.
Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports*, *100*, 126. doi:10.2307/20056429
Cheuvront, S. N., Goodman, D. A., Kenefick, R. W., Montain, S. J., & Sawka, M. N. (2008). Impact of a protective vest and spacer garment on exercise-heat strain. *European Journal of Applied Physiology*, *102*, 577–583.
Daanen, H. A. M., & Koerhuis, C. L. (2003). *Performance degradation of protected soldier* (TNO-rapport no. TM-03-A029). Soesterberg.
Dempsey, P. C., Handcock, P. J., & Rehrer, N. J. (2013). Impact of police body armour and equipment on mobility. *Applied Ergonomics*, *44*, 957–961.
Dempsey, P. C., Handcock, P. J., & Rehrer, N. J. (2014). Body armour: the effect of load, exercise and distraction on landing forces. *Journal of Sports Sciences*, *32*, 301–306.
Girden, E. R. (1992). *ANOVA: Repeated measures* (Vol. 84). Thousand Oaks, CA: Sage.
Handcock, P., & Dempsey, P. (2011). Fit to serve. A review of the New Zealand police physical competency test. *Journal of Science and Medicine in Sport*, *14*, 56.
Jung, C. M., Haight, M. J., & Freivalds, A. (2004). Pushing and pulling carts and two-wheeled hand trucks. *International Journal of Industrial Ergonomics*, *35*, 79–89.
Kim, J. H., Roberge, R., Powell, J. B., Shafer, A. B., & Jon Williams, W. (2012). Measurement accuracy of heart rate and respiratory rate during graded exercise and sustained exercise in the heat using the Zephyr BioHarness. *International Journal of Sports Medicine*, *34*, 497–501.
Kratcoski, P. C. (2004). Police education and training in a global society: Guest editor's introduction. *Police Practice and Research*, *5*, 103–105.
Larsen, B., Netto, K., & Aisbett, B. (2011). The effect of body armor on performance, thermal stress, and exertion: A critical review. *Military Medicine*, *176*, 1265–1273.
Lonsway, K. A. (2003). Tearing down the wall: Problems with consistency, validity, and adverse impact of physical agility testing in police selection. *Police Quarterly*, *6*, 237–277.
Majchrzycka, K., Brochocka, A., Łuczak, A., & Łężak, K. (2013). Ergonomics assessment of composite ballistic inserts for bullet-and fragment-proof vests. *International Journal of Occupational Safety and Ergonomics*, *19*, 387–396.
Mol, E., & de Vries, W. H. K. (2007). *Observatie en registratie van Fysieke Taken en Activiteiten bij de Nederlandse Politie*. Amsterdam, The Netherlands: VU University Amsterdam.
Mol, E., & Visser, B. (2002). *Minimale eisen aan fysieke vaardigheden en capaciteit bij de Nederlandse politie*. Amsterdam, The Netherlands: VU University Amsterdam.
Mol, E., & Visser, B. (2004). The development of a competence-based physical test for Dutch police recruits. *Medicine Science Sports Exercise*, *36*, 5.
Nielsen, B., Hyldig, T., Bidstrup, F., Gonzalez-Alonso, J., & Christoffersen, G. R. J. (2001). Brain activity and fatigue during prolonged exercise in the heat. *Pflügers Archiv*, *442*, 41–48.
Nybo, L., & Nielsen, B. (2001). Perceived exertion is associated with an altered brain activity during exercise with progressive hyperthermia. *Journal of Applied Physiology*, *91*, 2017–2023.
Orr, M. R., Pope, R., Johnston, V., & Coyle, J. (2014). Soldier occupational load carriage: a narrative review of associated injuries. *International Journal of Injury Control and Safety Promotion*, *21*, 388–396.
Park, H., Branson, D., Petrova, A., Peksoz, S., Jacobson, B., Warren, A., … Kamenidis, P. (2013). Impact of ballistic body armour and load carriage on walking patterns and perceived comfort. *Ergonomics*, *56*, 1167–1179.

Plat, M. J., Frings-Dresen, M. H. W., & Sluiter, J. K. (2011). A systematic review of job-specific workers' health surveillance activities for fire-fighting, ambulance, police and military personnel. *International Archives of Occupational and Environmental Health*, *84*, 839–857.
Rajakaruna, N., Henry, P. J., Cutler, A., & Fairman, G. (2017). Ensuring the validity of police use of force training. *Police Practice and Research*, *18*, 507–521.
Renden, P. G., Nieuwenhuys, A., Savelsbergh, G. J., & Oudejans, R. R. D. (2015). Dutch police officers' preparation and performance of their arrest and self-defence skills: A questionnaire study. *Applied Ergonomics*, *49*, 8–17.
Ricciardi, R., Deuster, P. A., & Talbot, L. A. (2007). Effects of gender and body adiposity on physiological responses to physical work while wearing body armor. *Military Medicine*, *172*, 743–748.
Schram, B., Hinton, B., Orr, R., Pope, R., & Norris, G. (2018). The perceived effects and comfort of various body armour systems on police officers while performing occupational tasks. *Annals of Occupational and Environmental Medicine*, *30*, 15.
Staller, M. S., Zaiser, B., & Körner, S. (2017). From realism to representativeness: Changing terminology to investigate effectiveness in self-defence. *Martial Arts Studies*, *4*, 70–77.
Straatmeijer, J., Visee, H., & Collard, D. (2017). *Evaluatie Fysieke Vaardigheidstoets Politie*.(pp. 75–76). Amsterdam. Retrieved from https://www.rijksoverheid.nl/documenten/rapporten/2017/09/01/tk-bijlage-evaluatie-fysieke-vaardigheidstoets-politie
Strating, M., & Bakker, R. H. (2008). *De Fysieke vaardigheidstoets: klaar voor de start. (Background, standardisation, reference times and manual of the PCT for the Dutch police)*. De Bilt, The Netherlands: Landelijk programma HRM Politie.
Strating, M., Bakker, R. H., Dijkstra, G. J., Lemmink, K. A., & Groothoff, J. W. (2010). A job-related fitness test for the Dutch police. *Occupational Medicine*, *60*, 255–260.
Stubbs, D., David, G., Woods, V., & Beards, S. (2008). Problems associated with police equipment carriage with body armour, including driving. *Contemporary Ergonomics*, *153*, 23–28.
Taylor, N. A., Lewis, M. C., Notley, S. R., & Peoples, G. E. (2012). A fractionation of the physiological burden of the personal protective equipment worn by firefighters. *European Journal of Applied Physiology*, *112*, 2913–2921.
Tomes, C., Orr, R. M., & Pope, R. (2017). The impact of body armor on physical performance of law enforcement personnel: a systematic review. *Annals of Occupational and Environmental Medicine*, *29*, 14.
Tucker, R. (2009). The anticipatory regulation of performance: the physiological basis for pacing strategies and the development of a perception-based model for exercise performance. *British Journal of Sports Medicine*, *43*, 392–400.
Wickwire, J., Bishop, P. A., Green, J. M., Richardson, M. T., Lomax, R. G., Casaru, C., … Doss, B. (2007). Physiological and comfort effects of commercial "wicking" clothing under a bulletproof vest. *International Journal of Industrial Ergonomics*, *37*, 643–651.
Zephyr technology cooperation. (2016). OmniSense analysis help. Retrieved from https://www.zephyranywhere.com/media/download/omnisense-analysis-help-20-apr-2016.pdf

Appendix

The formulas for calculating physiological intensity and load

(a) Physiological intensity is calculated by the Omnisense software using the following formula: Physiological intensity = 0.2*(%HRmax – 50). If %HRmax < 50% the physiological intensity = 0 and if %HRmax > 100 the physiological intensity = 10 (Zephyr technology cooperation, 2016).
(b) Physiological load is calculated based on physiological intensity as follows: Physiological load = (sum of all physiological intensity values)*(epoch(s)/60) (Zephyr technology cooperation, 2016). The epoch was 1 second, so the physiological load is calculated as the sum of all physiological intensity values divided by 60.