Aging and Health Research 4 (2024) 100196

Contents lists available at ScienceDirect

Aging and Health Research

journal homepage: www.elsevier.com/locate/ahr

The accuracy of bedside attention tests for delirium detection in older outpatients with cognitive impairment

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ARTICLE INFO

Keywords:
Attention tests
Delirium
Older outpatient
Older adults

ABSTRACT

Background: To determine the test accuracy of four observations, three explorations and four short tests commonly used in psychiatric examinations to detect attention disorders related to delirium in older outpatients.
Method: We performed a test accuracy study among 86 older patients referred for cognitive screening to an outpatient clinic of a psychiatric institution. Eleven index tests were applied without knowledge of the reference standard. A geriatrician or psychiatrist blinded to the results of the index tests determined the reference diagnosis with DSM-IV-TR criteria. Observations were lack of adequate/ regular eye-contact, dozing off during conversation, dozing off when not stimulated, and losing the point of story. Explored was lack of concentration during activities, difficulty following conversation, and being easily distracted. Serial 7s, WORLD spelled backward, months of the year backward (MOTYB) and counting back from 20 to 0 were applied. Test accuracy was calculated for the single tests and combinations.
Results: Dozing off during conversation scored high specificity (97.9 %) as did dozing off when not stimulated (97.9 %), but both had low sensitivity (< 27.9 %). Test accuracy of the exploration questions was low. Serial 7s and WORLD spelled backwards had high sensitivity (92.7 %, respectively 80.5 %) but low specificity (< 51.1 % %). The best combination was MOTYB with WORLD spelled backward (sensitivity of 63.4 %, specificity of 77.8 %).
Conclusions: No single observation, exploration or short test of attention was found to have both high sensitivity and specificity. Probably, attention deficits in delirium are best detected with a combination of observations and short tests as part of a comprehensive psychiatric examination.

1. Introduction

Delirium is a serious neuropsychiatric disorder characterised by a (sub)acute disturbance of attention, circadian rhythm, and cognition. It is often accompanied by hallucinations, agitation and affect liability. Delirium can have potentially severe consequences such as longer hospital stay, poor cognitive and functional recovery, increased risk of nursing home placement and death [1]. It is estimated that one-third of delirium cases goes undetected in hospitals and nursing homes. The overlap of symptoms with dementia, depression and other psychiatric disease can make it difficult to distinguish delirium from other psychiatric syndromes [2]. Lack of trained health professionals also plays a role.

Many guidelines advise to screen older patients more often to help detect delirium more quickly [3]. Several instruments have been developed for use by nurses or lay interviewers, such as the Delirium Observation Screening Scale (DOSS), the Confusion Rating Scale (CRS) and the Delirium Symptom Interview (DSI) [4–6]. Other screening tools were validated for use by geriatricians, such as the 4-AT [7]. In addition, diagnostic tools for delirium such as the CAM and the DRS-R98 are used to screen for delirium [8,9]. However, most of these instruments require quite some time to administer regularly [6,9], and some have not been validated in patients with dementia [10], or require training, expertise and experience to be administered correctly [8,9].

It is likely that the lack of an easy-to-use and rapid screening tool for delirium has tampered the implementation of regular screening [11]. Rapid tests can be administered within a few minutes and are usually single tests of attention. Examples are the Month of the Year Backward, and Single Question in Delirium [12,13]. A review of 27 test accuracy studies concluded that of the many rapid tests only the Observational

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https://doi.org/10.1016/j.ahr.2024.100196
Received 25 October 2023; Received in revised form 5 June 2024; Accepted 12 June 2024
Available online 17 June 2024
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Scale of Level of Arousal (OSLA) and the Richmond Agitation Sedation Scale (RASS) had reproduced high sensitivity and specificity for delirium in older patients [11].

A comprehensive psychiatric examination commonly covers multiple observations, explorations, and test to detect attention disorders. Examples are observing whether a patient dozes off during conversation, exploring whether he can focus on a conversation, and testing whether he can recite the months of the year backwards. The brevity and simplicity of the single tools might facilitate frequent screening for delirium, especially if they are highly sensitive [14]. The application would not require additional training, expertise, or time of the staff, nor pose a burden to the patients. However, many commonly used tests have not been systematically validated. The aim of this study was to determine the test accuracy of four observations, three explorations and four test that are commonly used in psychiatric examinations to detect attention disorders related to delirium in older patients living at home, a subject that is not studied often.

2. Methods

2.1. Design and participants

This test accuracy study was performed prospectively between May 2015 and September 2016 among older patients referred for dementia screening and multidisciplinary psychosocial care at home to an outpatient clinic of a psychiatric institution. The patients were referred by their general practitioner, a psychiatrist or a geriatrician and resided in and around Rotterdam, the Netherlands. The patients had cognitive disorders with or without psychological or neuropsychiatric symptoms, and some were suspected of delirium. Although our clinic does not use an age cut-off in the referral criteria, we generally see adults over the age of 65 years.

After referral, a patient's allocation to a specific team member was determined by the reason for referral, the experience and expertise of the team member, and the district of residence. Three team members contributed to the data collection for the current study.

All community-dwelling patients referred for the first time during the study period were eligible to participate. We excluded hospitalized and institutionalized patients who were referred for a one-off consultation and patients who were referred for the second time during the study period. There were no other exclusion criteria. We aimed to include at least 80 participants, 40 participants with delirium and 40 participants without delirium. Patients were enrolled in each study group until the group size was met.

The Medical Ethics Committee of the Erasmus University of Rotterdam, The Netherlands, approved the study. The committee granted a waiver for consent of patients because data was collected as part of (enhanced) daily medical care. The study did not pose a risk to the patients. The STROBE Guidelines were used to present our work [16].

2.2. Measurements

A geriatrician (or psychiatrist) and a registered psychiatric nurse (or a psychologist) assessed the patients. They visited most patients at least twice at home or in the care-centre where they lived. An informal or professional caregiver was usually present.

During the first visit, a nurse or psychologist applied the eleven index tests. They observed the patient during the conversation and scored the following four observations:

(1) The patient makes regular and adequate eye contact throughout the conversation.
(2) The patient dozes off once or more often during the conversation.
(3) The patient dozes off once or more often if the researcher does not focus on the patient (but on the caregiver for example).
(4) The patient has difficulty getting to the point of a story.

Next, the patient's opinion about his attention and concentration was explored. The three explorations were:

(1) Are you able to concentrate sufficiently during your activities?
(2) Do you find it difficult to follow a conversation?
(3) Are you easily distracted?

Finally, the following four attention tests were applied:

(1) Serial 7s [17],
(2) WORLD spelled backward (in Dutch, WORST is used) [18],
(3) Month of the year backward to June (MOTYB), and
(4) Counting back from 20 to 0 [19].

For each test, the cut-off was one mistake, i.e. the tests needed to be made without a mistake. Instructions were given to the assessors and written on the scoring form for the tests. The eleven index tests were applied without knowledge of the results of the reference standard.

A geriatrician or psychiatrist blinded to the results of the index tests determined the reference diagnosis with DSM-IV-TR criteria [15]. He diagnosed delirium after an interview with the patient and his caregiver, a psychiatric examination and a physical examination had taken place. Standardized blood- and urine tests were ordered. Cognitive functioning was tested with the Mini-Mental State Examination and the Clock Drawing Test [18,20]. The MOCA was used if the former two tests did not give enough information [21]. The medical file was checked for (abrupt changes in) cognitive functioning, behaviour and other symptoms of delirium. The delirium diagnosis was based on the criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR). The geriatrician and psychiatrist had no knowledge of the results of the index tests.

The following patient characteristics were extracted from the patient's electronic file: age, sex, presence of pre-morbid cognitive decline or dementia, and type of dementia. In addition, precipitating risk factors of delirium were recorded, and categorized as: drug-intoxication or withdrawal, metabolic/endocrine disorder, infection (intra-cranial or systematic), neoplasm (intra-cranial or systematic), cerebrovascular accident, heart failure, and other disease. This categorization has been introduced in a previous study in a similar outpatient population [22]. We also extracted how many patients with delirium died within a month. Finally, if patients with delirium had pre-morbid cognitive decline without a formal diagnosis of dementia, the diagnosis of dementia was postponed until the delirium had remitted and the cognitive status of the patient could be re-evaluated. This diagnostic information was obtained from the medical file as well.

2.3. Statistical analysis

The analysis consisted of three parts. First, we used descriptive statistics to describe the age and sex of the patients. Next, we calculated the test accuracy of the eleven single index tests in terms of the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) with 95 % confidence interval. Then, the index tests with high sensitivity (>80 %) were combined with the tests with high specificity (>80 %) to investigate whether a combination of tests would perform better than a test alone. In these calculations, the patients who scored positive on both tests were considered test positive. Finally, a subgroup analysis was performed to calculate test accuracies of the index tests in patients with and without dementia. We used SPSS v.25 for data analysis with the genlin-command for test accuracy.

3. Results

3.1. Study population

In this study, 86 patients were included. The mean age was 80.5

years old (SD 7.9; range 53.4–95.4) and twenty patients were male (23.3 %). Twenty-five patients had a prior diagnosis of dementia (29.1 %). Eleven patients were newly diagnosed with dementia at intake (12.8 %), and 15 received this diagnosis after the delirium had remitted (17.4 %).

Forty-one patients had delirium. The identified precipitating risk factor of delirium was an infection (mostly urinary tract infection or pneumonia) in 23 patients (56.1 %), drug intoxication in 10 (24.4 % %), metabolic disturbance in 8 (19.5 %), cerebrovascular accident in 2 (4.9 %), heart failure in 2 (4.9 %), and other diseases in 5 patients (12.2 %). Some patients had two underlying risk-factors. Also, three patients died within a month. The basic information of all participants is presented in table 1.

3.2. Test accuracy

Table 2 shows the sensitivity, specificity, PPV and NPV of the eleven index tests. The sensitivity of the four observations was low (at most 37 %), but the specificity of "dozing off during conversation" and "dozing off when not stimulated" was very high (at least 97.9 %). The PPV of "lack of adequate and regular eye-contact", "dozing off during conversation" and "dozing off when not stimulated" was high (> 90.8 %) but the NPV was moderate (< 59.7 %). The three explorations scored low sensitivity (at most 61.1 %) and moderate specificity (at most 77.3 %). The PPV of all items was moderate (< 64.4 %) and the NPV was low (< 59.7 %). Of the attention tests, Serial 7s showed very high sensitivity (92.7 %) and WORLD spelled backwards also scored high sensitivity (80.5 %), but specificity was low (15.6 % respectively 51.1 %). The PPV and NPV of the two tests was moderate.

Next, given the results of the single tests (sensitivity or specificity >80 %), we calculated the test accuracy of the following four combinations: Serial 7s with "dozing off when not stimulated", Serial 7s with "dozing off during conversation", WORLD with "dozing off when not stimulated", WORLD with "dozing off during conversation", and MOTYB with WORLD spelled backward. All combinations showed low sensitivity (at most 30.0 %), high specificity (at least 97.7 %), high PPV (> 89.9 %) and low to moderate NPV (< 59.8 %). Only MOTYB with WORLD spelled backward showed moderate sensitivity (63.4 %), specificity (77.8 %), PPV (72.2 %) and NPV (70.0 %).

3.3. Subgroup analysis

Table 3 shows the results of the subgroup analysis in participants with and without dementia. Only "difficulty following conversation" and "counting back from 20 to 0" showed clear differences in test accuracy between the groups. Both items had high specificity for delirium in patients without dementia (80.0 % respectively 90.0 %), but sensitivity for delirium was still moderate (50.5 % respectively 55 %), as was NPV (61.5 % respectively 66.7 %). The PPV was moderate to high in the patients without dementia (71.4 % respectively 84.6 %). In patients with dementia the specificity of "difficulty following conversation" was low (30 %) and the specificity of "counting back from 20 to 0" was moderate (67.6 %). The sensitivity of both items was low (55.0 respectively 38.2 %), as was the PPV (44.0 respectively 52.0 %), and NPV (40.0 respectively 54.3 %).

Table 1
Characteristics of study population.

	Patients (n= 86)
Demographic characteristics	
Age, mean (SD)	80.5 (7.9)
Sex, n (%)	
-male	20 (23.3)
-female	66 (76.7)
Medical diagnosis	
Prior diagnosis of dementia (%)	25 (29.1)
Patients with probable delirium (%)	41 (47.7)

Table 2
Test accuracy of commonly used attention observations, explorations and tests in delirium.

Index test	Sensitivity (95 % CI)	Specificity (95 % CI)	PPV (95 % CI)	NPV (95 % CI)
Observations				
Lack of adequate/ regular eye-contact	29.3 (16.9 – 44.2)	88.9 (77.6 – 95.9)	70.6 (47.1 – 88.3)	58.0 (46.2 – 69.2)
Dozing off during conversation	22.3 (12.4 – 37.2)	97.9 (90.1 – 99.9)	90.9 (65.7 – 99.5)	58.2 (47.2 – 68.7)
Dozing off not stimulated	27.9 (16.0 – 42.3)	97.9 (91.0 – 99.9)	92.3 (70.3 – 99.5)	59.7 (48.6 – 70.2)
Losing point conversation	36.6 (23.0 – 51.8)	31.1 (18.9 – 45.4)	32.6 (20.3 – 46.8)	35.0 (21.5 – 50.4)
Explorations				
Lack of concentration during activities	61.0 (45.7 – 74.9)	28.9 (17.1 – 43.1)	43.9 (31.5 – 56.8)	44.8 (27.7 – 62.8)
Difficulty following conversation	41.5 (27.2 – 56.7)	75.6 (61.8 – 86.5)	60.7 (42.3 – 77.3)	58.6 (45.8 – 70.7)
Easily distracted	43.9 (29.4 – 59.1)	77.3 (63.6 – 87.9)	64.3 (45.9 – 80.2)	59.6 (46.7 – 71.8)
Tests				
Serial 7s	92.7 (82.1 – 98.1)	15.6 (7.0 – 27.9)	50.0 (38.9 – 61.1)	70.0 (39.3 – 91.5)
WORLD spelled backwards	80.5 (66.7 – 90.6)	51.1 (36.8 – 65.3)	60.0 (46.8 – 72.3)	74.2 (57.3 – 87.3)
MOTYB	73.2 (58.5 – 85.1)	64.4 (49.9 – 77.3)	65.2 (50.9 – 77.9)	72.5 (57.6 – 84.7)
Counting back from 20 to 0	58.5 (43.3 – 72.8)	68.9 (54.6 – 81.1)	63.2 (47.3 – 77.3)	64.6 (50.5 – 77.1)

MOTYB stands for months of the year backward.

4. Discussion

The aim of this study was to determine the test accuracy of four observations, three explorations and four short tests for delirium in older outpatients with and without dementia. No single observation, exploration or short test of attention was found to have high sensitivity and specificity. Serial 7s showed very high sensitivity (92.7 %), and "dozing off during conversation" and "dozing off when not stimulated" very high specificity (at least 97.9 %). The best combination was MOTYB with WORLD spelled backward with moderate sensitivity (63.4 %), specificity (77.8 %). In the subgroup analyses of patient with and without dementia only "difficulty following conversation" and "counting back from 20 to 0" showed clear differences between the groups.

4.1. Test accuracy

Some of the items that we tested showed (very) high sensitivity or (very) high specificity, but none had both. The specificity of the observations "dozing off during conversation" and "dozing off when not stimulated" was high. This means these observations can be used to capture alterations in attention and consciousness which are key features of delirium, and rule in delirium when the test result is positive. Previous studies on standardized short observations of attention, like the m-RASS [23] and GAR [24], reported similar findings in hospitalized patients.

In addition, our study showed (very) high sensitivity for Serial 7s and WORLD backward. This indicates that these attention tests can be used to rule out delirium when the test result is negative. The same results

Table 3
Test accuracy of observations, explorations and tests for patients with dementia (bold) and without dementia (non-bold).

Test	Sensitivity	Specificity	PPV	NPV
Observations				
Lack of adequate/ regular eye-contact	**28.6 (12.5 – 49.6)**	**84.0 (66.6 – 94.7)**	**60.0 (30.9 – 85.4)**	**58.3 (42.1 – 73.4)**
Lack of adequate/ regular eye-contact	30.0 (13.2 – 51.7)	90.0 (62.8 – 99.4)	85.7 (50.6 – 99.1)	39.1 (21.1 – 59.4)
Dozing off during conversation	**13.0 (3.4 – 30.4)**	**96.3 (84.7 – 99.8)**	**75.0 (27.8 – 98.4)**	**56.5 (42.1 – 70.2)**
Dozing off during conversation	36.4 (18.6 – 57.2)	95.5 (81.5 – 99.7)	88.9 (59.5 – 99.3)	60.0 (43.5 – 75.1)
Dozing off not stimulated	**21.7 (8.4 – 41.0)**	**96.3 (84.7 – 99.8)**	**83.3 (44.6 – 99.0)**	**59.1 (44.4 – 72.8)**
Dozing off not stimulated	36.4 (18.6 – 57.2)	95.5 (81.5 – 99.7)	88.9 (59.5 – 99.3)	60.0 (43.5 – 75.1)
Losing point conversation	**23.8 (9.3 – 44.4)**	**40.0 (22.5 – 59.5)**	**25.0 (9.8 – 46.2)**	**38.5 (21.5 – 57.6)**
Losing point conversation	50.0 (29.1 – 70.9)	20.0 (6.7 – 40.5)	38.5 (21.5 – 57.6)	28.6 (9.9 – 54.5)
Explorations				
Lack of concentration during activities	**66.7 (45.4 – 84.1)**	**28.0 (13.1 – 47.2)**	**43.8 (27.5 – 60.9)**	**50.0 (25.5 – 74.5)**
Lack of concentration during activities	55.0 (33.6 – 75.2)	30.0 (13.2 – 51.7)	44.0 (25.8 – 63.3)	40.0 (18.3 – 64.0)
Difficulty following conversation	**55.0 (33.6 – 75.2)**	**30.0 (13.2 – 51.7)**	**44.0 (25.8 – 63.3)**	**40.0 (18.3 – 64.9)**
Difficulty following conversation	50.5 (29.1 – 70.9)	80.0 (59.5 – 93.3)	71.4 (45.5 – 90.1)	61.5 (42.4 – 78.5)
Easily distracted	**42.9 (23.4 – 63.9)**	**76.0 (57.2 – 89.7)**	**60.0 (35.1 – 81.7)**	**61.3 (43.8 – 77.0)**
Easily distracted	45.0 (24.8 – 66.4)	78.9 (57.6 – 92.9)	69.2 (42.3 – 89.3)	57.7 (38.7 – 75.3)
Tests				
Serial 7s	**95.2 (80.7 – 99.7)**	**8.0 (1.4 – 22.7)**	**46.5 (32.1 – 61.3)**	**66.7 (16.1 – 97.7)**
Serial 7s	90.0 (72.2 – 98.3)	25.0 (9.8 – 46.2)	54.5 (37.7 – 70.7)	71.4 (35.0 – 94.6)
WORLD spelled backwards	**76.2 (55.6 – 90.7)**	**48.0 (29.3 – 67.1)**	**55.2 (37.2 – 72.3)**	**70.6 (47.1 – 88.3)**
WORLD spelled backwards	85.0 (65.6 – 96.0)	55.0 (33.6 – 75.2)	65.4 (46.3 – 81.6)	78.6 (53.4 – 94.2)
MOTYB	**76.2 (55.6 – 90.7)**	**60.0 (40.5 – 77.5)**	**61.5 (42.4 – 78.5)**	**75.0 (53.8 – 90.2)**
MOTYB	70.0 (48.3 – 86.8)	70.0 (48.3 – 86.8)	70.0 (48.3 – 86.8)	70.0 (48.3 – 86.8)
Count back 20-0	**38.2 (23.2 – 55.0)**	**67.6 (51.7 – 81.1)**	**52.0 (32.9 – 70.7)**	**54.3 (40.0 – 68.2)**
Count back 20-0	55.0 (33.6 – 75.2)	90.0 (72.2 – 98.3)	84.6 (59.6 – 97.3)	66.7 (48.0 – 82.4)

MOTYB stands for Months of the year backward.

were found among adults admitted for acute assessment in a university general hospital [14], older patients with delirium, dementia, comorbid delirium-dementia seen in a consultation liaison psychiatry service [25], and older patients admitted to an acute care hospital and a long-term-care facility [26]. To our knowledge, no prior studies have been performed in outpatient care.

We expected larger differences between the test accuracies of the items for delirium among participants with and without dementia. One would expect that specificity would be lower if dementia is present. A study in older patients admitted to general and geriatric medicine showed that MOTYB performed best in patients with and without dementia. The 2-item screen with the highest sensitivity for delirium in patients with and without dementia is the combination of "What is the day of the week?" and "Months of the year backwards" with a sensitivity of 93 % (95 % CI: 81 %–99 %) and specificity of 64 % (95 % CI: 56 %–70 %) in patients without dementia and a higher sensitivity of 96 % (95 % CI: 82 %–100 %) and lower specificity of 43 % (95 % CI: 24 %–63 %) in patients with dementia (27). A possible explanation for the lack of differences in the test accuracy of explorations in our study might be that both patient groups are not able to self-report attention deficits.

The best test-combination in our study was MOTYB with WORLD spelled backwards. However, relative to the sensitivity of the single tests (73.2 % and 80.5 % respectively), the sensitivity of the test combinations was moderate or low (64 %). When another study among patients in a general hospital combined MOTYB with "What is the day of the week", specificity dropped from 92 % to 61 % [27]. Hence, it seems that combining tests does not improve sensitivity and specificity compared to that of single tests.

In view of the results of all eleven single tests, it seems that the observations and tests together provide an accurate picture of the presence of attention disorders. Other authors concluded that the most precise screening was achieved by simultaneously performing MOTYB and assessing for subjective/ objective confusion [16,18]. A review of bedside-tests of attention showed that clinical subjective rating of attention in conjunction with the month of the years backwards had the best discriminatory ability to identify delirium and discriminate it from dementia and/ normal cognition [14]. Moreover, it is important that besides attention disorders, other (core) features of delirium should be carefully assessed. Therefore, we advise to use at least the specific observations "dozing off during conversation" and "dozing off when not stimulated" and the sensitive tests MOTYB and WORLD spelled backwards as part of a comprehensive psychiatric examination.

One of the strengths of this study is that this study was performed in older outpatients, a group that is not studied often in delirium research. In addition, we studied a variety of simple bedside tests that do not require collateral history, which is useful in clinical practice. Furthermore, the index tests were applied without knowledge of the reference standard, and the reference standard was applied without knowledge of the index tests. The scoring of the index tests was determined a priori.

One of the limitations is that the study population was small. Consequently, some confidence intervals were too large to allow firm conclusions. This might also be the reason that the study did not show different results in patients with and without dementia. Although referred participants were enrolled and no exclusion criteria applied, selection of more complex cases into the study probably occurred because the nurses and psychologist that collected the data were usually assigned such cases relatively more often than their colleagues. Previous Dutch studies in the same setting reported a prevalence of delirium varying between 16 % and 19 % [22,28]. In addition, the results of this study in outpatients cannot be generalised easily to other settings such as hospitals and nursing homes.

5. Conclusion

No single observation, exploration or short test of attention was found to predict the presence of delirium well in this study. Some

observations were highly specific, and some short tests highly sensitive. Therefore, we conclude that a comprehensive psychiatric examination covering multiple observations and tests to detect attention disorders still seems the best way to identify delirium.

Statement of ethics

The medical ethics committee of Erasmus Medical Centre Rotterdam, an academic research institute that we consulted, has approved the study protocol.

Funding sources

Parnassia Stimuleringsfonds funded the study. This is an internal fund of Parnassia, the current or former employer of two of the authors, to stimulate research in the organisation.

Data sharing

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

CRediT authorship contribution statement

D.W.P. Quispel-Aggenbach: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sytse U Zuidema:** Supervision, Methodology. **Hendrika J Luijendijk:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We would like to thank Jan Geelhoed and Cathrien den Hartogh for their help with data-collection.

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