Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

British Journal of Psychology (2009), 100, 49–70
© 2009 The British Psychological Society
The British Psychological Society
www.bpsjournals.co.uk

Healthy ageing, perceived motor-efficacy, and performance on cognitively demanding action tasks

Lauren M. Potter[1]*, Madeleine A. Grealy[2] and Rory C. O'Connor[3]
[1]Department of Applied Psychology, Heriot-Watt University, Edinburgh, UK
[2]Department of Psychology, University of Strathclyde, Glasgow, UK
[3]Department of Psychology, University of Stirling, Stirling, UK

Current measures assessing older adults' functional ability detect existing limitations on essential tasks rather than changes in other aspects of functioning that could indicate future limitations. The perceived motor-efficacy scale was developed to measure capability beliefs of healthy older adults across a range of daily action tasks. Subscales were developed through interviews with older volunteers and academics, then administered to participants aged 60–96 ($N = 300$). Factor analysis of subscale scores produced 10 subscales. These demonstrated strong internal reliability, which was replicated with a second sample aged 60–92 ($N = 167$). The influence of perceived motor-efficacy on performance of cognitively demanding action tasks was investigated with a third sample aged 60–88 ($N = 134$). On a task assessing the inhibition of an inappropriate action, older adults in their 80s with high confidence produced minor errors, whereas those with lower confidence produced extreme errors. On another task assessing the ability to inhibit a previously learnt action, those with high levels of perceived motor-efficacy performed better amongst those least able to inhibit, but more poorly among those most able. Perceived motor-efficacy may therefore be useful in identifying older adults at risk of functional limitations and enabling interventions before the onset of illness.

STUDY 1: DEVELOPMENT OF A PERCEIVED MOTOR-EFFICACY SCALE FOR OLDER ADULTS

As we enter the 21st century we are living in an increasingly ageing society. By 2025 there will be more people in the UK aged 60 and above than under 25 for the first time in history (Government Actuary's Department Projections, 2003). This sharp increase in the number of older people poses a serious challenge in terms of maintaining and

*Correspondence should be addressed to Dr Lauren M. Potter, Department of Applied Psychology, School of Life Sciences, Heriot-Watt University, Edinburgh, EH14 4AS, UK (e-mail: L.M.Potter@hw.ac.uk).

DOI:10.1348/000712608X304478

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

enhancing functional ability in everyday life. One problem with the term 'functional ability' though is that it often refers to different constructs. This is because over the last 20 years two very separate literatures have emerged on ageing, one which addresses the effects on the 'mind' and another the effects on the 'body'. In the physical ageing literature, functional ability often refers to basic activities of daily living (e.g. Orbell, Johnston, Rowley, Davey, & Espley, 2001) while the role of cognitive functions are less acknowledged. Conversely, in the cognitive literature, everyday tasks such as remembering a medical regimen or planning a shopping route have been studied from a cognitive viewpoint (e.g. Phillips, Kliegel, & Martin, 2006) without accounting for the motor context in which these tasks take place. Indeed, it could be argued that successful performance on many daily tasks requires the integration of both cognitive and motor control abilities. Few studies though have investigated 'functional ability' throughout normal ageing in terms of performance on cognitively demanding action tasks.

Furthermore, the psychological factors associated with performance on such tasks, such as capability beliefs for daily action tasks (perceived motor-efficacy), have also not been investigated even though these may be important indicators of functioning. For example, older people with a low sense of perceived motor-efficacy may be at risk of excluding themselves from participation in daily activities, which is likely to lead to isolation and further losses of confidence and participation. It is therefore important to be able to identify those at risk of future problems so that independent participation can be maintained. Current measures of everyday functional ability, though, are not adequate, in that while they are designed to detect existing physical limitations on essential tasks, they fail to detect other age-related changes which could be precursors to future difficulties. Because of this, psychologists have previously viewed measures of older adults' motor functioning as only applicable to disciplines which focus on the rehabilitation of existing disabilities. The present authors believe, though, that to more fully understand the factors that influence how well we function as we get older, then changes in cognition and how these relate to the control of action throughout the course of normal ageing should be at the heart of psychological research.

One psychological factor shown to be a strong predictor of performance regardless of actual ability is the self-referent construct of perceived self-efficacy (Bandura, 1986, 1997). This is defined as an individual's perceived ability to perform a specific behaviour or task sometime in the near future. As perceived self-efficacy is by definition task-specific, it has greater predictive power than more global self-referent constructs such as locus of control, self-esteem and learned helplessness (Bandura, 1977).

Many different forms of self-efficacy have been used to predict a variety of goal-oriented behaviours in younger adults. A strong sense of self-efficacy is related to higher achievement, increased career development (Betz & Hacket, 1981), and better social integration (Kazdin, 1979). 'Can do' cognitions also facilitate cognitive processes, and in-turn, academic performance (Bandura, 1986). In terms of physical health, a high sense of self-efficacy is associated inversely with risky sexual behaviours and drug use, and positively with physical exercise and nutritional balance (e.g. Schwarzer & Fuchs, 1995). Regarding mental health, a high sense of self-efficacy is inversely associated with anxiety, helplessness, and depression (e.g. Blazer, 2002).

Research on the self-efficacy of older adults though has been carried out in fewer domains. Much of this literature is biased towards models of functional disability,

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

particularly the role of self-efficacy in recovery from illness or chronic disease. For example, a high sense of self-efficacy is related to enhanced performance of actions (such as step climbing and manual lifting) and exercises (such as jogging or swimming) among older people with chronic medical conditions including osteoarthritis (Orbell *et al.*, 2001), rheumatoid arthritis (Lorig, Chastain, Ung, Shoor, & Holman, 1989), diabetes (Alto, Uutela, & Aro, 1997), heart disease (Jenkins & Gortner, 1998), and among those undergoing rehabilitation following stroke (Hellstrom, Lindmark, & Fugl-Meyer, 2002), heart attack (Carroll, 1995), obstructive pulmonary disease (Toshima, Kaplan, & Reis, 1992), and hip fracture or joint replacement surgery (Ingemarsson, Frandin, Hellstrom, & Rundgren, 2000; Orbell *et al.*, 2001).

Despite this relative wealth of research on self-efficacy and pathological ageing, the literature is limited concerning how the beliefs of healthy older people relate to performance across a range of everyday tasks. Firstly, existing scales focus on single functional movements (such as step climbs or arm rotations) which are poorly reflective of the combination of movements inherent to many daily action tasks. Climbing a set of stairs, for example, involves more than moving each leg in isolation, thus increases in the ability to perform functional exercises do not necessarily impact upon the performance of everyday activities (O'Leary, Shoor, Lorig, & Holman, 1989). Secondly, current scales span a narrow range of 'essential' tasks required for independent living (such as washing and toileting, getting in and out of bed) rather than a broad range of skills requiring different cognitive and motor abilities. While the essential tasks are important from a clinical perspective in terms of identifying people who are no longer able to live independently, they still fail to provide us with insights into important changes that develop with older age across a broad range of tasks which could be indicators of future functional difficulties. Thus, while current self-efficacy scales are designed to detect existing functional limitations, it is crucial in terms of early interventions to be able to identify people who are at risk of limitations in the future, and in this respect the current scales need developed further.

Indeed, when it comes to identifying people at risk of functional limitations before any serious difficulties have emerged, perceived self-efficacy beliefs for daily actions may be particularly important for older adults. This is because while higher levels of self-efficacy are associated with higher levels of performance amongst younger adults, older adults have to construct their perceived self-efficacy appraisals in the face of age-related declines in perceptual (e.g. Burton-Danner, Owsley, & Jackson, 2001), cognitive (e.g. Schaie, 1996), and motor (e.g. Amrhein, 1996) abilities. As these declines emerge, they must be accompanied by perceived self-efficacy reappraisals in order to guide successful and safe performance (Bandura, 1982). This means that if older people do not successfully acknowledge age-related declines in their abilities as they emerge, then higher levels of self-efficacy or overestimating actual motor abilities could put them at risk of physical injury and subsequent functional limitation, whilst underestimating could result in self-exclusion leading to further losses of confidence and isolation. Perceived self-efficacy beliefs for daily action tasks may therefore have important and unique functional consequences for healthy older adults.

A new instrument was thus developed to measure healthy older adults' perceived motor capabilities across a range of daily action tasks; the perceived motor-efficacy scale for older adults.

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

Method

Participants

The first sample used to develop the questionnaire comprised 300 participants aged between 60 and 96 years (mean age = 77 years 4 months, standard deviation = 10 years 2 months). A second independent sample used to test the reliability of the subscales comprised 167 participants aged between 60 and 92 (mean age = 74 years 6 months, standard deviation = 9 years 0 months). Participants were recruited over a broad section of socio-economic strata and educational and occupational backgrounds, including The Senior Studies Institute at Strathclyde University, day clubs, churches, leisure clubs, and residential housing centres for older adults in Edinburgh and Glasgow. As the present study aimed to investigate processes of normal rather pathological ageing, we recruited only healthy older people; volunteers were screened cognitively using the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), and in terms of physical health using a self-report medical history questionnaire and a thorough examination by a physiotherapist and biomechanist. The participants recruited were those volunteers who were not taking any medications likely to affect performance, not cognitively impaired as defined by an MMSE score >23, and who were healthy as defined by the absence of any diagnosed chronic physical or mental illnesses, recent surgeries, hospitalization, or feelings of illness. Written consent was obtained from all participants and the study was conducted with local ethical approval. Table 1 summarizes the characteristics of these participants.

Table 1. Characteristics of samples 1 and 2 (Study 1)

Age group	*N* Female	*N* Male	*N* Total	Mean age (years/months)
Sample 1				
60–69	36	46	82	66y 2m
70–79	23	47	70	74y 5m
80–89	66	52	118	83y 8m
90+	19	11	30	92y 1m
N total	144	156	300	
Sample 2				
60–69	36	23	59	68y 2m
70–79	30	23	53	74y 9m
80–89	26	25	51	83y 8m
90+	2	2	4	92y 1m
N total	94	73	167	

Design and procedure

The stages outlining the development of the perceived motor-efficacy scale (Table 2) ranged from item generation, subscale construction and refinement, to reliability testing with a second sample. These stages are in line with previously published studies (e.g. Lorig *et al.*, 1989).

Item generation

Items were generated through two main processes; a literature review of difficulties experienced by older adults during daily action tasks, and a series of interviews with

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

Table 2. Stages of perceived motor-efficacy scale development

1. Item generation
   a. Literature review of everyday difficulties for older adults
   b. 80 items generated following series of interviews with academics
   c. 80 items refined following series of interviews with older adults
2. Initial subscale construction
   a. Like items grouped to form 13 subscales, plus 2 culturally specific subscales
   b. Items within each subscale agreed to theoretically belong there by 2 impartial layman and 1 academic judge
3. All 15 subscales (80 items) administered to first sample ($N = 300$)
4. Item analysis
   a. Reduction of 15 subscales to a maximum of 5 items each
   b. Internal reliability of 15 subscales after item removal
5. Development of confidence indicator
6. Factor analysis
   a. 13 subscale scores factor analysed (2 culturally specific scales and confidence indicator not included)
   b. Factor structure used to combine 13 subscales into 7 post-factor analysis subscales
7. Item analysis of post-factor analysis subscales
   a. Reduction of each post-factor analysis subscale to a maximum of 5 items
   b. Internal reliability of 7 subscales after item removal
8. Reliability analysis with second sample ($N = 167$)

academics and older adults. Age-related deterioration has been documented for physical abilities, motor control, and cognitive abilities, all of which are required to different extents for different action tasks. Regarding physical abilities, age-related deteriorations have been found for strength (e.g. Vandervoort, 1992), flexibility (e.g. Hay, 1996), balance (e.g. Tang & Woollacott, 1996), and speed (e.g. Amrhein, 1995). Thus, items were constructed based on lifting objects, stretching, a danger of falling, and fast movements, respectively. For motor abilities, deteriorations have been documented in motor co-ordination (e.g. Greene & Williams, 1996) and the visual guidance of action (e.g. Patla, Prentice, & Gobbi, 1996). Therefore items were constructed based on gross co-ordination of the arms and legs, fine co-ordination of the hands and fingers, and visual guidance of hand movements. Finally, deteriorations have been found in cognitive abilities which are relevant to action, including the ability to inhibit irrelevant information (Hasher & Zacks, 1988) and previously relevant or inappropriate responses (Dempster, 1992). Thus, items were constructed relating to distracting situations and the use of novel objects and motor procedures. Self-report statements were used, such as ‘I consider myself to have good physical stamina’, to which participants could rate their agreement on a scale from 0 (strongly agree) to 10 (strongly disagree).

Six academics with a professional interest in motor abilities were invited to participate in two sets of interviews. In the first, they were asked to consider the type and range of daily activities that would be beneficial for older people to participate in as part of their everyday lives. Following these discussions, and consistent with the literature review at the start of the item generation phase, it was decided that the questionnaire needed to include self-efficacy perceptions of movements ranging from fine to gross, sitting to standing, stationary to locomotor, and involving both the upper and lower body. As a result of these two processes, 60 daily motor-efficacy items were generated and subsequently presented to the academics in a second set of interviews.

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

Following further discussions, it was decided that of the 60 items generated, perceptions of some daily motor activities were underrepresented. These gaps were therefore filled with a further 18 items, resulting in 78 items altogether.

In a third set of interviews, four of the older participants were asked to read through the items, comment upon them and outline any difficulties they experienced in interpreting them. Following this feedback, several items were reworded to prevent ambiguity. The older adults also emphasized that they were very aware of slowing down physically and mentally, and of having to 'keep an eye' on their movements more closely these days. It was therefore important to include the items 'I feel that my movements are slower than they used to be' and 'I don't have to monitor or keep an eye on my movements more than I used to' within the questionnaire. No other items were removed or added following these interviews, thus the questionnaire comprised 80 items at this stage.

Subscale construction

Subscales were constructed by grouping items with a similar theoretical basis, that is, which according to the literature involved the same type of specific motor ability. Each subscale was then named accordingly. For example, items relating to the use of hand movements were grouped together and labelled 'perceived manual ability'. This process resulted in 13 subscales, plus a further 2 subscales that we regarded as specific to some cultures only. For example, as walking outdoors in cold or snowy weather is more common in Scotland compared to some other countries, such items were grouped into one culturally specific 'perceived walking ability' subscale. Similarly, using a knife and fork to eat, or using taps that twist on and off, are common methods within British society but not necessarily within others. Thus, items relating to such activities were grouped into one culturally specific 'perceived manual ability' subscale. Two impartial layman judges and one expert judge then agreed that the items within each of the 15 subscales theoretically belonged there.

Questionnaire administration

The questionnaire was administered to sample 1 ($N = 300$). Participants read the following instructions:

> 'below are a number of statements, which may describe how you feel about your ability to perform certain physical activities. Please read each one carefully and indicate as honestly as you can how true each statement is for you. To answer, please write beside each item the appropriate number, choosing from one of the following:
>
> 0 (strongly disagree) 1 2 3 4 5 6 7 8 9 10 (strongly agree)'

The questionnaire items were presented in a randomized order, with approximately one in five items reversed.

Results

Item analysis

Item analysis is a statistical procedure enabling the development of self-report questionnaires by demonstrating the internal reliability of a set of items. This is represented by an alpha coefficient, which ranges in theory from 0 (highly unreliable) to 1 (perfect reliability). In practice, an alpha of .7 is generally considered to be a 'good'

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

reliability value, particularly for larger sample sizes (Nunnally, 1978). Each subscale was subjected to item analysis for two purposes; to limit each to a maximum of five items (to present a set of concise subscales), and to demonstrate internal reliability of each subscale after item removal. Items were removed if they showed a correlation coefficient with the total subscale score of less than .3, and an alpha-if-item-deleted value greater than the alpha coefficient for the overall subscale (Zacks, 1992). After each item removal, the reliability analysis was repeated until five items or less remained in each subscale. Following this phase, the number of questionnaire statements was reduced from 80 to 60, and each of the 15 subscales demonstrated high internal reliability, as represented by alpha coefficients ranging from .78 to .94 (Table 3).

Table 3. Alpha coefficients and number of items pre- and post-item removal for 15 subscales

	Pre-item removal		Post-item removal	
Subscale	No. items	α	No. items	α
1. Walking ability	4	.91	4	.91
2. Manual ability	7	.92	5	.91
3. Motor ability in demanding contexts	4	.94	4	.94
4. Motor ability in the face of ageing	8	.90	5	.89
5. Motor ability relative to same-age peers	6	.89	3	.90
6. Physical endurance	6	.82	5	.91
7. Physical flexibility	4	.83	3	.81
8. Physical strength	3	.78	3	.78
9. Balance control	4	.85	3	.86
10. Motor co-ordination ability	7	.88	4	.90
11. Manual ability in novel contexts	6	.82	5	.81
12. Limits to motor ability	6	.90	5	.92
13. Confidence in movement quality	9	.91	5	.88
14. Walking ability (culturally specific)	4	.94	4	.94
15. Manual ability (culturally specific)	2	.83	2	.83
Total	80		60	

Development of confidence indicator

Item analysis revealed that the scores for the two items 'I feel that my movements are slower than they used to be' and 'I don't have to monitor or keep an eye on my movements more than I used to' were so similar across older participants that the alpha coefficient was weakened when they were included in any subscale. Thus, the two items did not statistically fit in any subscale measuring perceived motor-efficacy for specific motor domains. It was important though to include these items because unusually low scores would identify highly cautious individuals, whereas unusually high scores would identify highly confident individuals. These two items were therefore separated into a separate confidence indicator subscale to identify older adults who are highly cautious or confident relative to their peers. As a basis of peer comparison, the confidence indicator scores from sample 1 ($N = 300$) were standardized by calculating 95% confidence limits for male and female participants in their 60s, 70s, and 80s. It is emphasized that rather than being cut-off points to make clinical diagnoses, these limits are indicators that certain individuals might be at risk of functional difficulties due to unusually high levels of caution or confidence. Table 4 details these lower (below which

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

high caution is indicated) and upper limits (above which high confidence is indicated) for sample 1 (and for sample 2 which shall be addressed shortly).

Table 4. 95% confidence intervals for samples 1 ($N = 300$) and 2 ($N = 167$) on confidence indicator

		Sample 1			Sample 2	
		95% of scores fall between			95% of scores fall between	
Sex and decade	*N*	Lower limit	Upper limit	*N*	Lower limit	Upper limit
60s Female	36	5	7	36	4	7
60s Male	46	7	9	23	6	9
70s Female	23	2	4	30	2	3
70s Male	47	2	3	23	2	4
80s Female	66	2	3	26	2	3
80s Male	52	1	2	23	1	3
90s Female	19	1	2	2	1	1
90s Male	11	1	1	2	1	1

Factor analysis

Subscales were scored by summing the item scores and dividing by the number of items (producing a 'mean score' for each subscale). This allowed comparisons between subscales which varied in the number of items they contained. Subscales 14 and 15 related to culturally specific items, and as subscale 16 was the confidence indicator and not representative of a specific motor domain, scores were factor analysed for the first 13 subscales only (54 items in total). Scores for subscales, not single items, were used in this analysis. This was to reduce the subject-to-variable ratio to a practical number of participants, as the subject-to-variable ratio of an 80-item questionnaire would require at least 400 participants for a valid factor analysis of item scores (e.g. Tabachnick & Fidell, 1996). This method of analysing subscale scores was appropriate because the subscales had already demonstrated internal reliability, and it is in line with previously published studies (e.g. Ingledew & Hardy, 1996).

Factor analysis, using principal components extraction and varimax rotation, identified seven principal components which accounted for 93.98% of the total variance. In the total rotated solution, the proportion of variance accounted for by each of the seven components was 25.34, 24.61, 12.68, 11.80, 7.39, 6.35, and 5.81%, respectively. A combination of different subscales loaded highly on components 1, 2, and 4, and only single subscales loaded highly on components 3, 5, 6, and 7. Table 5 illustrates the loadings of the 13 subscales on each of the 7 components.

Item analysis (post-factor analysis)

The initial 13 subscales were combined into 7 post-factor analysis subscales by grouping together items from different subscales that loaded highly on the same component. Each of these seven subscales was then subjected to item analysis to reduce the number of items per subscale to a maximum of five items again, and to demonstrate the internal reliability of each new subscale after item removal. In this way, the number of items was reduced from 54 to 31, and each subscale was renamed accordingly. Each of the seven subscales demonstrated high internal reliability with alpha coefficients ranging from .81 to .95 (Table 6).

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

Table 5. Factor loadings of 13 subscales on 7 components

Component	Combination of initial subscales	Loading
1	12. Perceived limits to motor ability	.82
	4. Perceived motor ability in the face of ageing	.81
	8. Perceived physical strength	.72
2	2. Perceived manual ability	.78
	9. Perceived balance control	.74
	10. Perceived motor co-ordination ability	.64
	13. Perceived confidence in movement quality	.61
3	5. Perceived motor ability relative to same-age peers	.89
4	1. Perceived walking ability	.67
	3. Perceived motor ability in demanding contexts	.61
5	11. Perceived motor ability in novel contexts	.65
6	7. Perceived physical flexibility	.60
7	6. Perceived physical endurance	.60

Table 6. Alpha coefficients and number of items pre- and post-item removal for 7 subscales

	Pre-item removal		Post-item removal	
Subscale	No. items	α	No. items	α
1. Motor ability in the face of ageing	13	.95	5	.93
2. Ability to coordinate precise movements	17	.97	5	.93
3. Motor ability relative to same-age peers	3	.90	3	.90
4. Motor ability in demanding contexts	8	.96	5	.95
5. Motor ability in novel contexts	5	.81	5	.81
6. Physical flexibility	3	.81	3	.81
7. Physical endurance	5	.91	5	.91
Total	54		31	

The revised questionnaire comprised 10 subscales (39 items in total). These were named as perceived: motor ability in the face of ageing; ability to coordinate precise movements; motor ability relative to same-age peers; motor ability in demanding contexts; motor ability in novel contexts; physical flexibility; physical endurance; walking ability (culturally specific); and manual ability (culturally specific). The final subscale was the confidence indicator.

Reliability analysis with a second sample

To retest the reliability of each subscale, the revised questionnaire was administered to a second independent sample of older adults ($N = 167$).

Internal reliability

Internal reliability analysis was performed on the first nine subscales (37 items) only as the confidence indicator could not be included. These demonstrated good internal reliability with alpha coefficients ranging from .68 –.85, compared to .81–.95 in the first sample (Table 7).

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

Table 7. Alpha coefficients for 9 subscales: comparison of samples 1($N = 300$) and 2 ($N = 167$)

	Alpha coefficient	
Subscale: Perceived. . .	Sample 1	Sample 2
1. Motor ability in the face of ageing	.93	.84
2. Ability to coordinate precise movements	.93	.85
3. Motor ability relative to same-age peers	.90	.72
4. Motor ability in demanding contexts	.95	.82
5. Motor ability in novel contexts	.81	.68
6. Physical flexibility	.81	.77
7. Physical endurance	.91	.85
8. Walking ability (culturally specific)	.94	.77
9. Manual ability (culturally specific)	.83	.69
10. Confidence indicator	N/A	N/A

Confidence indicator

With the first sample ($N = 300$) the confidence indicator scores were standardized as 95% confidence intervals for male and females in each older decade. To investigate the reliability of these ranges in scores, this process was repeated using the second sample ($N = 167$). The intervals produced were then compared between samples 1 and 2 (see Table 4). The confidence intervals produced by the second sample approximated those of the first sample. The original confidence intervals were therefore retained as the standardized scores for males and females within each older decade.

Final questionnaire

The final questionnaire (Table 8) comprised seven subscales, two culturally specific subscales, and one confidence indicator (10 subscales or 39 items in total).

Discussion

The consensus between academics and older adult volunteers concerning the type and range of daily motor activities to include within each subscale supports the validity of items generated. In addition, the high alpha coefficients found with the first sample ranged from .78 to .94 before, and from .81 to .95 after employing factor analysis. These high alpha coefficients were reproduced with the second sample, demonstrating internal reliability for each subscale.

Factor analysis of subscale scores showed that unique sets of subscales loaded highly on each component, with factor loadings ranging from .61 to .82. On each component there were several subscales that loaded highly, and the alpha coefficients of each combined subscale following factor analysis remained high. Thus, the method of factor analysing subscale scores was successful.

As overestimation of one's capabilities could result in physical injury and subsequent functional limitations, and underestimation could result in increasing loss of functional independence, a measure which could identify older adults at risk of such functional limitations could be important in informing interventions to enhance functional ability. It was not possible however to determine the accuracy of older adults' perceived

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

Table 8. The perceived motor-efficacy scale for older adults

1. I consider myself to have good physical stamina
2. I am unlikely to have difficulties using new household objects that I have never used before
3. *I usually do not attempt complex movements because I find it difficult to perform them well*
4. I rarely avoid certain movements in case I fall
5. I believe I am able to control my movements as well as most others my age
6. I am not likely to have difficulty getting about in unfamiliar surroundings, like a new house/town
7. I do not feel more anxious than I used to when carrying out certain movements
8. I am not likely to have any difficulties getting about outside when the weather is cold
9. *I am not very good at activities involving precise manual movements*
10. *I am likely to have some difficulty using a knife and fork*
11. I feel confident at adjusting movements to improve their accuracy or efficiency
12. I do not have to monitor, or keep an eye on my movements, more than I used to
13. Physically, I rarely feel too stiff to perform certain movements well
14. I feel I am good at activities involving hand-to-eye coordination, such as catching a ball
15. I believe I would have no problems running for a bus if I had to
16. I rarely worry about climbing up or down stairs
17. I am not likely to have any difficulties getting about in hot weather
18. I feel I am good at activities such as bending down to reach for something
19. I expect to be able to shift smoothly from one movement to another
20. I believe I can learn most movements if I set my mind to it
21. *I feel that my movements are slower than they used to be*
22. *I do not feel as competent as most others my age when it comes to performing movements*
23. If I were to trip-up, I am confident that I could prevent myself from falling to the ground
24. *I am likely to have difficulty walking to the top of a large flight of stairs*
25. *I find it difficult to perform more complex movements if I have not practised them before*
26. I am unlikely to have difficulty driving an unfamiliar type of car
27. I expect to be able to learn new movements within a short time
28. *I usually do not attempt more complex movements because I feel I am likely to injure myself*
29. If I have any difficulties performing movements, I rarely give in easily
30. I am not likely to have any difficulties walking outside when the ground is covered in leaves
31. When I plan movements, I am certain I can make them work
32. I consider myself to be good at activities requiring the precise timing of actions
33. I am confident in my ability to walk a long distance without any difficulties
34. I feel I am good at sports or other leisure activities compared to most others my age/sex
35. *I am likely to have difficulties getting about in the snow*
36. *I often expect my joints to feel too stiff to perform certain movements well*
37. I am not likely to have difficulties getting about outside in the wind
38. I believe I can easily perform the actions required when using kitchen or bathroom taps
39. *I will rarely attempt to master a tricky action*

Items: Each is scored out of 10 (from '0 = strongly disagree' to '10 = strongly agree'). Italicised items are reverse scored. Subscales: Perceived motor ability in the face of ageing = items 7, 16, 27, 3, 4; Perceived ability to perform precise movements = 9, 14, 19, 32, 11; Perceived motor ability relative to same-age peers = 5, 22, 34; Perceived motor ability in demanding contexts = 37, 15, 23, 24, 33; Perceived ability in novel motor contexts = 2, 6, 25, 26, 28; Perceived physical flexibility = 13, 18, 36; Perceived physical endurance = 1, 20, 29, 31, 39; Perceived walking ability (culturally specific) = 8, 17, 30, 35; Perceived manual ability (culturally specific) = 10, 38; Confidence indicator = 12, 21. Subscale scores are calculated by summing item scores then dividing by the number of items (mean score).

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

capabilities, as comparisons between perceived and actual ability for each item were not within current resources and shall be addressed in future studies instead. It was possible though to use the confidence indicator to identify older people who are highly cautious or confident compared to their peers, as this might still be an important indicator of functional limitations. Confidence intervals for the indicator subscale were calculated for males and females within each older decade using formulas designed for specific sample sizes (Rees, 1998). As the perceived motor-efficacy questionnaire was initially developed using a large sample of older adults over a broad cross-section of Scottish society ($N = 300$), the scores indicating highly cautious and confident individuals are likely to be broadly representative of the wider population of older adults. Indeed, these scores were approximated with a smaller second sample of older adults.

STUDY 2: AGEING, PERCEIVED MOTOR-EFFICACY AND PERFORMANCE ON COGNITIVELY DEMANDING ACTION TASKS

This study investigates the extent to which perceived motor-efficacy beliefs relate to action errors on two tasks that are analogous to important everyday tasks. In this initial test of the perceived motor-efficacy scale it was decided to focus on action tasks which were cognitively demanding. In particular it was aimed to use two action tasks which required good inhibitory abilities for successful performance. This was because inhibitory abilities are thought to be key mechanisms underlying age-related cognitive decline (Hasher & Zacks, 1988), and other studies have shown that these tasks reveal important age-related declines (Potter & Grealy, 2006, 2008). The first action task involved copying the experimenter's manual movements while wiping a surface with a sponge, except for one particular lifting action which participants were instructed not to copy. This task assessed the ability to inhibit executing a prepotent but inappropriate motor response during an ongoing action. This is required in many everyday contexts in which an individual's planned or current actions are rendered inappropriate because of unexpected changes in the surrounding environment (e.g. Dempster, 1992). For example, in the event of a trip or slip, the prepotent response is to put one's arms out to break the fall. Due to age-related physical changes, however, older people are more likely than younger people to break or fracture wrist or arm bones in such situations (e.g. Tinetti, Liu, & Claus, 1993), therefore the medical advice they are given requires them to inhibit the prepotent response of putting their arms out in front of them if they do happen to fall. Similarly, when driving a vehicle which unexpectedly begins to skid, the prepotent response is to press the brake pedal. Braking on ice, however, is dangerous and drivers are instructed during training they must refrain from braking and instead steer into the skid. Skidding on a patch of ice therefore requires drivers to inhibit the prepotent response of braking and take necessary evasive action instead. Previous research (Potter & Grealy, 2008) has shown that the frequency of inappropriate actions produced (inhibition failures) increased as expected with older age, but that inhibitory errors were not all or none; even when the inappropriate response was successfully inhibited, errors controlling the ongoing action under these demands still emerged from as young as the 40s, which is 20 years earlier than found in the cognitive literature (e.g. Comalli, Wapner, & Werner, 1962).

The second action task involved grasping a cup in different orientations to assess the ability to inhibit or override a previously learnt action in favour of a novel action. This ability is particularly important in everyday contexts in order to use novel everyday

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

items. For example, driving a different car with manual controls for indicators and lights in a different position, using modern designs like taps that are not turned on by twisting the handle, or recording a favourite television programme using modern digital technology, all require the ability to override already established procedures in favour of a new set of actions. Previous research (Potter & Grealy, 2006) has shown that most participants failed to inhibit the old response by the 60s, which is 10–20 years earlier than found in the cognitive literature (e.g. Haaland, Vranes, Goodwin, & Garry, 1987).

Method

Participants

134 older adults aged 60–88 were recruited over a broad section of socio-economic strata and educational and occupational backgrounds in Glasgow, Ayrshire, and Stirling (mean age = 73 years 5 months, standard deviation = 8 years 7 months). As in the previous study, only healthy volunteers who passed the screening stage (using the MMSE (Folstein *et al.*, 1975), a self-report medical history questionnaire and a thorough examination by a physiotherapist and biomechanist) were recruited as participants. The characteristics of these older adults are detailed in Table 9.

Table 9. Characteristics of sample 3 (Study 2)

Age group	*N* Female	*N* Male	*N* Total	Mean age (years/months)
Sample 3				
60–69	34	20	54	66y 1m
70–79	24	19	43	74y 2m
80–89	20	17	37	83y 2m
N total	78	56	134	

Design

The influence of perceived motor-efficacy beliefs on performance was investigated in the wiping task using a mixed design (with both within and between-subjects variables), and in the grasping task using a between-subjects design.

To assess the ability to inhibit executing an inappropriate motor response during an ongoing action, the wiping task was based on a go/no-go design. Participants were instructed that when the experimenter changed wiping direction from left/right to forwards/backwards, they must copy this (go signal), but that if the experimenter changed from left/right wiping to lifting their sponge up/down (no-go signal) they must not copy this. Participants were instructed that if the experimenter performed this lifting action, they were to stop themselves from copying it and instead continue with the ongoing action of wiping back and forth. The number of inhibition failures produced by participants were measured. Other motor errors were produced when participants succeeded to inhibit the inappropriate action but did not manage to continue wiping back and forth undisturbed. These additional errors were pauses in movement, pause/wipe sequences of error, wiping in the wrong direction (forwards/backwards or diagonal instead of left/right), and switching direction on the left/right plane of movement. The number of these errors produced by participants were also measured (thus six error types were measured in total).

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

To assess the ability to ignore a previously learnt action in favour of a novel one (the grasping task), participants were instructed that over a number of trials they would be presented with a cup that had grasp contact points printed on its rim, which would indicate where they should place their thumb and forefinger when grasping the cup. They were told that the orientation of these grasp contact points may or may not vary on each trial, and were strictly instructed to decide on the movements required to grasp the cup (movement planning time) before proceeding to execute that action. Participants were primed to plan for an easy grasp action by presenting them with an easy grasp orientation for the first set of trials. Based on findings from previous research (Frak, Paulignan, & Jeannerod, 2001), 56° was used as the easy grasp orientation. Once movement planning times to this orientation had stabilized, the easy grasp orientation was then unexpectedly switched to a novel and more complex grasp orientation requiring additional movement planning time (−22°). Successful inhibition of the previously established action plan (easy grasp) was demonstrated by an increase in planning time from the last of the easy grasp trials to the first complex grasp trial.

Materials

For the wiping task a Flock of Birds® motion tracking system was used which measured positional changes at 120 Hz. Sensors were inserted into two large hand held sponges which were placed on opposite sides of a surface. Participants stood with the sponge positioned to the side of their dominant hand, and the experimenter stood opposite them with their sponge directly opposite the participant's.

For the grasp task a plastic cup was used (marked with two contact points on the rim), as well as movement planning time apparatus consisting of an electronic sensor and push down button both wired to a millisecond timer. The orientation of the cup was concealed under a box, and when the experimenter lifted the box to reveal the grasp orientation of the cup, the millisecond timer started and was stopped when the participant had decided on the movements required and lifted their hand from the push down button to perform the planned grasp action. The perceived motor-efficacy scale for older adults was also employed.

Procedure

The order in which the questionnaire and two action tasks were completed was randomized. For the wiping experiment, participants were strictly instructed to copy all of the experimenter's actions bar one. It was emphasized that when the experimenter changed wiping direction from left/right to forwards/backwards, they should copy this (go signal), but if the experimenter changed from left/right wiping to lifting their sponge up/down, they should not copy this and should continue instead with the ongoing action of wiping left and right (no-go signal). 30 go and no-go signals were presented in randomized order, thus participants completed 60 trials altogether.

For the grasp experiment, participants sat in front of a desk with the cup placed centrally in front of them and the push down button in front of their dominant hand. Before each trial the experimenter positioned the cup and the box was placed over it to conceal the grasp orientation. Participants were asked to place their hand on the button at the start of each trial, and when the cup was revealed, grasp it at the marked contact points. They were strictly instructed not to lift their hand from the button until they had

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

planned the movements required to reach and grasp. Participants were primed to expect and plan for an easy grasp action (56° with respect to the frontal plane) by repeatedly presenting the cup in the easy grasp orientation. Performance was judged to have stabilized when planning times were within 100 milliseconds of each other for 3 consecutive trials. Without indication to participants that a shift between conditions was about to occur, they were then presented with a complex grasp (−22° relative to the frontal plane), and this was repeated until planning times were within 100 milliseconds of each other for 3 consecutive trials.

Results

The pattern of results from the wiping and grasping tasks are summarized below (for full details see Potter & Grealy, 2006, 2008) then followed by the main analysis of how different levels of perceived motor-efficacy were related to performance.

Inhibiting the execution of a prepotent action (wiping task)

There were differences between older adults in the types of wiping actions inappropriately executed. Table 10 details the number of each error type produced by each age group.

Table 10. Wiping task: mean error scores (with standard deviations) for each error type and age group

	Age group		
Error type	60s	70s	80s
Inhibition failure (lift)	2.37 (1.70)	3.21 (1.70)	4.57 (2.03)
Pause	6.02 (4.95)	7.35 (5.96)	9.86 (7.49)
Pause/wipe sequence	2.19 (3.64)	1.26 (2.45)	4.65 (5.45)
Wrong direction (diagonal)	4.17 (3.74)	3.30 (3.44)	4.22 (5.08)
Wrong direction (forward/backwards)	8.28 (7.20)	5.86 (8.32)	6.22 (7.72)
Switching direction between left/right	6.41 (5.06)	6.70 (4.80)	10.78 (6.68)

A two-way mixed ANOVA was employed using the greenhouse-geisser epsilon correction and partial eta-square as a measure of effect size. This found significant main effects of error type ($F(5, 655) = 25.72$, $p < .05$, MS error = 225.81, ES = .16) and age ($F(2, 131) = 13.39$, $p < .05$, MS error = 116.05, ES = .17). Of greater interest though was a significant interaction between age and error type ($F(10, 655) = 2.87$, $p < .05$, MS error = 25.20, ES = .14). A *post hoc* Tukey's HSD test revealed that the interaction resulted from participants in their 80s making significantly more inhibition errors than those in their 60s ($p < .05$) and significantly more extreme errors of pausing and pause/wipe sequences of error compared to those in their 60s ($p < .05$) and 70s ($p < .05$). Those in their 70s also produced significantly more pauses compared to those in their 60s ($p < .05$).

It was then investigated whether these differences between age groups were influenced by perceived motor-efficacy beliefs. Table 11 details the perceived motor-efficacy subscale scores for each age group of older participants who completed the two motor tasks.

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

Table 11. Mean scores (with standard deviations) on each perceived motor-efficacy subscale for each age group

	Age group		
Subscale: Perceived. . .	60s	70s	80s
1. Motor ability in the face of ageing	6.30 (2.34)	5.03 (2.10)	3.98 (2.41)
2. Ability to coordinate precise movements	7.74 (1.51)	7.87 (1.41)	6.62 (1.65)
3. Motor ability relative to same-age peers	7.85 (1.35)	8.57 (1.27)	9.23 (1.09)
4. Motor ability in demanding contexts	6.70 (1.88)	6.18 (2.21)	4.94 (1.97)
5. Motor ability in novel contexts	6.03 (1.93)	5.64 (1.46)	4.37 (1.89)
6. Physical flexibility	6.80 (2.12)	6.24 (2.08)	5.02 (2.48)
7. Physical endurance	7.51 (1.29)	7.73 (1.51)	7.08 (1.75)
8. Walking ability (culturally specific)	7.31 (1.84)	6.75 (1.92)	5.85 (2.04)
9. Manual ability (culturally specific)	9.11 (1.15)	9.32 (0.86)	8.83 (1.36)
10. Confidence indicator	4.44 (2.65)	3.57 (2.50)	1.45 (2.06)

The relationship between perceived motor-efficacy and motor errors could not be assessed using ANCOVA, because the assumption of homogeneity of regression slopes was not met (different age groups showed different relationships between perceived motor-efficacy and performance). When homogeneity of regression slopes are violated in this way, the most appropriate method of assessing the influence of covariates on performance is to translate scores on the covariates into different levels of an independent variable, a method known as ‘blocking’ (Tabachnick & Fidell, 1996). This method takes participants’ scores on the potential covariates (each perceived motor-efficacy subscale) and groups participants into low, medium, or high ‘blocks’ according to their score (a score between 0 and 4.9 out of 10 = ‘low’, between 5.0 and 6.9 = ‘medium’, and between 7.0 and 10 = ‘high’). Perceived motor-efficacy was thus translated into three levels of another independent variable.

As homogeneity of regression slopes was violated in ANCOVA for the independent variable of age group, an interaction was expected between this factor and the blocking independent variable of perceived motor-efficacy. A series of three-way mixed ANOVAs were conducted, each time with a different perceived motor-efficacy subscale as the blocking independent variable. In each the level of perceived motor-efficacy for that subscale (low, medium, and high) was crossed with age (60s, 70s, and 80s) and error type (6 types).

The only ANOVA to show a significant interaction between perceived motor-efficacy and age or error type was one in which scores on the confidence indicator were used as the blocking independent variable. Using the greenhouse-geisser epsilon correction and partial eta-square as a measure of effect size, the ANOVA found the same significant main effects of error type and age and the significant interaction between error type and age reported in the earlier two-way ANOVA. When perceived motor-efficacy was included as a third independent variable, a new result was found; a significant interaction between confidence indicator scores, age, and error type ($F(10, 625) = 1.84$, $p < .05$, MS error = 48.91, ES = .16). A *post hoc* Tukey’s HSD test revealed different relationships between scores on the confidence indicator and performance for different age groups. For older adults in their 60s and those in their 70s, those with high confidence produced significantly fewer minor errors of wiping in the wrong direction (forward/backwards instead of left/right) than those with lower confidence ($p < .05$).

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

In contrast, older adults in their 80s with high confidence produced significantly more minor errors of wiping in the wrong direction (forward/backwards as well as diagonal wiping this time) than those with lower confidence ($p < .05$). Furthermore, older adults in their 80s produced significantly more of the more extreme errors (pausing during the action as well as stopping and starting sequences of error) when they had low rather than high confidence.

Inhibiting a previously learnt action in favour of a novel action (grasping task)

For each participant, the time taken to inhibit the old action and replan the new one was calculated by subtracting the mean planning time of the last three easy grasp trials from the planning time for the first complex grasp trial. Thus the shorter the time taken to inhibit, then the poorer the performance and vice versa. Although the mean time taken to inhibit decreased with each older age group (60s = 165.42 milliseconds, 70s = 126.28 milliseconds, and 80s = 87.68 milliseconds) there was increasingly large variation in the time taken to inhibit with each older age group. Coefficients of variation found that the amount of variation nearly doubled from the 60s to 70s and again from the 70s to 80s, indicating increasingly large differences in inhibitory abilities with each older age group. This is consistent with evidence that older adults show increased variability with decreased functioning (e.g. Ylikoski *et al.*, 1999), and suggests that chronological age may not be the most revealing method by which to investigate performance in older age. Instead, investigating the characteristics associated with higher and lower levels of functioning could inform distinctions between healthy and pathological ageing and help develop early interventions (Hedden & Gabrieli, 2004). As such, characteristics (i.e. perceived motor-efficacy) associated with excellent, good or poor inhibition groups were analysed this time rather than differences between age groups.

Those who showed an increase in planning time on the first complex grasp equal to or above the mean increase of young adults in their 20s–30s (404 milliseconds, Potter & Grealy, 2006) were classified as having excellent inhibition, those who showed an increase of greater than 100 milliseconds but less than 404 milliseconds were categorized as having good inhibitory skills, and those whose planning times did not increase or increased by less than 100 milliseconds were classed as having failed to inhibit. The cut-off point was 100 milliseconds because planning times within 100 milliseconds of each other were deemed in the procedure as stable scores, thus an increase of 100 milliseconds or less was considered as following on from rather than inhibiting the primed grasp plan.

A one-way between-subjects ANOVA confirmed a significant difference in the time taken to inhibit between the three categories of inhibition ability ($F(2, 131) = 181.91$, $p < .05$, $MS\,error = 37{,}387.28$, $ES = .74$). As the assumption of homogeneity of regression slopes was not met the method of blocking was used (Tabachnick & Fidell, 1996) whereby participants' scores on each perceived motor-efficacy subscale were translated into three levels of another independent variable. A series of two-way between-subjects ANOVAs were conducted, each time with a different perceived motor-efficacy subscale as the blocking independent variable. In each ANOVA, the level of perceived motor-efficacy for that subscale (low, medium, and high) was crossed with category of inhibition ability (poor, good, and excellent).

The ANOVAs showed a significant interaction between level of perceived motor-efficacy and category of inhibition ability for 7 out of the 10 subscales. Subscales in

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

which level of perceived motor-efficacy did not interact with category of inhibition ability were perceived motor ability relative to same-age peers ($F(4, 125) = 0.129$, $p = .88$), perceived walking ability ($F(4, 125) = 0.726$, $p = .576$), and perceived manual ability ($F(4, 125) = 0.36$, $p = .550$). Subscales in which level of perceived motor-efficacy showed a significant interaction with category of inhibition ability were perceived ability to perform precise movements ($F(4, 125) = 13.55$, $p < .05$, MS error $= 25,940.99$, ES $= .30$), perceived ability in novel motor contexts ($F(4, 125) = 5.46$, $p < .05$, MS error $= 33,186.53$, ES $= .15$), perceived motor ability in the face of ageing ($F(4, 125) = 3.73$, $p < .05$, MS error $= 34,681.15$, ES $= .11$), perceived physical flexibility ($F(4, 125) = 3.25$, $p < .05$, MS error $= 35,067.58$, ES $= .09$), perceived motor ability in demanding contexts ($F(4, 125) = 2.87$, $p < .05$, MS error $= 35,811.74$, ES $= .08$), perceived physical endurance ($F(4, 125) = 2.95$, $p < .05$, MS error $= 36,177.24$, ES $= .06$), and the confidence indicator subscale ($F(4, 125) = 2.50$, $p < .05$, MS error $= 36,233.60$, ES $= .07$).

Post hoc Tukey's HSD tests for each significant interaction showed that differences in the time taken to inhibit between low, medium, and high levels of perceived motor-efficacy differed between the three categories of inhibition ability (poor, good, and excellent). Firstly, for the groups who managed to inhibit, those with higher levels of perceived motor-efficacy took less time to inhibit (showing poorer performance) than those with lower levels on all 7 scales in question (all $p < .05$). In contrast, for the poor inhibition group, those with lower levels of perceived motor ability in demanding contexts took more time to inhibit (showing better performance) than those with higher levels ($p < .05$).

Discussion

Inhibiting executing a prepotent motor response during an ongoing action (wiping task)

Scores on the confidence indicator subscale influenced the pattern of motor errors in different ways for different age groups. Older adults in their 60s and 70s with high confidence produced significantly fewer minor errors (wiping in the wrong direction) than those with lower confidence. This is consistent with the literature showing that higher perceived capability beliefs are associated with enhanced performance among younger adults (Bandura, 1986; Betz & Hacket, 1981). However, older adults in their 80s showed a different pattern of errors than their younger counterparts. Firstly, those with high confidence produced significantly more minor errors of wiping in the wrong direction than those with lower confidence. Thus while higher levels of confidence are associated with better performance in younger adults and those in their 60s and 70s, the present findings are the first to show that when it comes to the oldest of the healthy older adults, higher levels of confidence do not always mean better performance. One explanation for this is that the oldest adults with the highest levels of confidence may be experiencing emerging declines which they have not yet reappraised and incorporated into their perceived capability beliefs. This could result in slight overestimation of their capabilities to the extent that they produced some minor errors. However, this study was an initial test to investigate how perceived motor-efficacy relates to performance on everyday-based action tasks and did not measure the accuracy of perceived capability beliefs by comparing them with actual capabilities for each subscale. Subsequent

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

analyses therefore aim to investigate the accuracy of perceived motor-efficacy beliefs and how this impacts performance throughout older age.

Secondly, although older adults in their 80s produced minor errors when high in confidence, they produced significantly more of the extreme errors (pausing during the action as well as stopping and starting sequences of error) when they had low confidence. This shows that for the oldest of healthy older adults, both high and low levels of confidence are associated with motor errors, but that more serious errors are produced with low confidence. One explanation is that older adults in their 80s experience more progressive declines than younger adults thus they may have to continuously or more periodically reappraise their perceived capabilities in line with their changing abilities in order to perform well. As such these oldest adults may be susceptible to motor errors when they are too high or too low in confidence. It is not clear however whether perceived motor-efficacy beliefs cause these errors, or vice versa, but if the perceived capability beliefs of older adults are shown in subsequent analyses to be important factors in determining functional ability, then the next avenue of future research is to develop new interventions to help older people accurately reappraise their changing abilities as they get older.

Inhibiting a previously learnt action in favour of a novel one (grasping task)

For those who succeeded to inhibit and performed as well as younger adults on the grasp task, higher levels of perceived motor-efficacy (specifically, perceived: ability to perform precise movements, ability in novel motor contexts, motor ability in the face of ageing, physical flexibility, motor ability in demanding contexts, physical endurance, as well as the confidence indicator subscale) showed significantly less time taken to inhibit, that is, poorer performance than lower levels of perceived motor-efficacy. Why higher levels of perceived motor-efficacy were linked with poorer performance for those who managed to inhibit is not clear. It could be that out of those who could inhibit, those with the highest levels of confidence may have been starting to show emerging declines but had not yet incorporated these into their perceived ability judgements. Whether these older people were slightly overestimating their capabilities though will be determined in future studies.

That perceived ability to coordinate precise movements was associated with performance for the successful inhibition group was not a surprising result given that the grasp inhibition task involved precise and coordinated grasp actions. The same argument holds for the other subscales that significantly interacted with inhibition ability category. However, why perceived manual ability did not interact with inhibition ability category is less clear, given that this was a manual task. Overall, it was perceived motor-efficacy in subscales such as perceived endurance and perceived ability in demanding motor contexts rather than the more basic perceived manual ability that seemed to encapsulate the challenges of the grasp task and detect emerging declines within certain ability categories. It could be that older adults of all ages are confident performing basic manual tasks with a strong motor rather than cognitive component such as turning a tap on and off. In this sense, the grasp task required more than just basic manual ability; performance was determined by abilities other than general manual ability alone. Thus, perceived manual ability may predict difficulties with the physical rather than cognitive control of actions, although further work is needed to investigate this.

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

On the other hand, for those who failed to inhibit on the grasp task (who showed no increase in decision time from the last easy grasp to the first hard grasp), higher levels of perceived motor ability in demanding contexts showed significantly more time taken to inhibit (better performance) than lower levels of perceived ability. Why the other subscales did not interact with performance for the inhibition failure group is less clear. It may be that the greatest demands for the inhibition failure group involved being able to inhibit the old grasp plan, rather than coordinate the movements themselves, whereas on the other hand, the inhibition part may have been easier than the physical co-ordination part for the successful inhibition group. Indeed, for the successful inhibition groups, higher levels of perceived physical endurance were linked with less successful performance, suggesting that the physical demands of the task may have been greater than the inhibitory demands of the task. Thus, whereas lower functioning older adults may experience considerable cognitive declines before physical declines, the reverse might be true for higher functioning older adults.

Conclusion

Previous researchers have argued that action is 'pre-shaped' in thought (Schwarzer, 1992), that is, that the preparation and execution of actions is influenced by mental representations, and in particular by beliefs about the self (Bandura, 1997). Although it is not clear whether perceived motor-efficacy caused action errors or vice versa, these findings are the first among healthy older people to demonstrate that those with lower and higher levels of perceived motor-efficacy show significant differences in performance on everyday-based cognitively demanding action tasks. However, this study was an initial test to investigate how perceived motor-efficacy relates to performance on everyday-based action tasks, rather than the presentation of a tool for clinical diagnoses. In addition, the accuracy of perceived capability beliefs was not measured in this study by comparing them with actual capabilities for each subscale. The main aim of subsequent analyses is to investigate whether perceived motor-efficacy beliefs are useful predictors of older people at risk of functional limitations by investigating their accuracy and how this impacts performance throughout older age. Such additional evidence will then be applied to informing interventions designed to help people more accurately appraise their action capabilities, and in-turn facilitate functional ability throughout the adult life-span and before the onset of serious functional limitations.

Acknowledgements

This study was funded by the EPSRC, and is part of a large-scale multidisciplinary project entitled 'the integration of biomechanical and psychological parameters of functional performance of older adults into a new computer aided design package for inclusive design'. We thank all the older adults who kindly volunteered to complete our testing session.

References

Aalto, A. M., Uutela, A., & Aro, A. R. (1997). Health related quality of life among insulin-dependent diabetics: Disease-related and psychosocial correlates. *Patient Education and Counseling*, *31*, 215–225.

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

Amrhein, C. (1996). Age-related slowing in movement parameterisation studies: Not what you might think. In A. M. Ferrandez & N. Teasdale (Eds.), *Changes in sensory motor behaviour in aging* (pp. 1–26). North Holland: Elsevier Science.

Amrhein, P. C. (1995). Evidence for task specificity in age-related slowing: A review of speeded picture-word processing studies. In P. Allen & T. Bashore (Eds.), *Age differences in word and language processing* (pp. 144–171). Amsterdam: Elsevier Science Publishers.

Bandura, A. (1977). Self-efficacy: Towards a unifying theory of behavioural change. *Psychological Review*, *84*, 191–215.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, *37*, 122–147.

Bandura, A. (1986). Scope of self-efficacy theory. *Journal of Social and Clinical Psychology*, *4*, 359–373.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W.H. Freeman.

Betz, N. E., & Hackett, G. (1981). The relationships of career-related self-efficacy expectations to perceived career options in college women and men. *Journal of Counseling Psychology*, *28*, 399–410.

Blazer, D. G. (2002). Self-efficacy and depression in late life: A primary prevention proposal. *Aging and Mental Health*, *6*(4), 315–324.

Burton-Danner, K., Owsley, C., & Jackson, G. R. (2001). Aging and feature search: The effect of search area. *Experimental Aging Research*, *27*, 1–18.

Carroll, D. (1995). The importance of self-efficacy expectations in elderly patients recovering from coronary artery bypass surgery. *Heart and Lung*, *24*(1), 50–59.

Comalli, P. E., Wapner, S., & Werner, H. (1962). Interference effects of Stroop color-word test in childhood, adulthood, and aging. *Journal of Genetic Psychology*, *100*, 47–53.

Dempster, F. N. (1992). The rise and fall of the inhibitory mechanism: Toward a united theory of cognitive development and aging. *Developmental Review*, *12*, 45–75.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-mental state. A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*(3), 189–198.

Frak, V., Paulignan, Y., & Jeannerod, M. (2001). Orinetation of the opposition axis in mentally simulated grasping. *Experimental Brain Research*, *136*, 120–127.

Government Actuary's Department Projections (2003). Downloaded from the World Wide Web January 2007 at http://news.bbc.co.uk/1/hi/uk/4012797.stm

Greene, L. S., & Williams, H. G. (1996). Aging and coordination from the dynamic pattern perspective. In A. M. Ferrandez & N. Teasdale (Eds.), *Changes in sensory motor behaviour in aging* (pp. 89–131). North Holland, Amsterdam: Elsevier Science.

Haaland, K. Y., Vranes, L. F., Goodwin, J. S., & Garry, P. J. (1987). Wisconsin card sorting test performance in a healthy elderly population. *Journal of Gerontology*, *33*, 345–346.

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. In G. G. Bower (Ed.), *The psychology of learning and motivation* (Vol. 22, pp. 193–225). San Diego, CA: Academic Press.

Hay, L. (1996). Posture control and muscle proprioception in the elderly. In A. M. Ferrandez & N. Teasdale (Eds.), *Changes in sensory motor behaviour in aging* (pp. 132–161). North Holland: Elsevier Science.

Hedden, T., & Gabrieli, J. D. E. (2004). Insights into the ageing mind: A view from cognitive neuroscience. *Neuroscience*, *5*, 87–96.

Hellstrom, K., Lindmark, B., & Fugl-Meyer, A. (2002). The falls-efficacy scale, Swedish version: Does it reflect clinically meaningful changes after stroke? *Disability and Rehabilitation*, *24*(9), 471–481.

Ingemarsson, A. H., Frandin, K., Hellstrom, K., & Rundgren, A. (2000). Balance function and fall-related efficacy in patients with newly operated hip fracture. *Clinical Rehabilitation*, *14*(5), 497–505.

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Copyright © The British Psychological Society
Reproduction in any form (including the internet) is prohibited without prior permission from the Society

Ingledew, D. K., & Hardy, L. (1996). Health behaviours reported as coping strategies: A factor analytical study. *British Journal of Health Psychology*, *1*, 263–281.
Jenkins, L. S., & Gortner, S. R. (1998). Correlates of self-efficacy expectation and prediction of walking behaviour in cardiac surgery elders. *Annals of Behavioural Medicine*, *20*, 99–103.
Kazdin, A. E. (1979). Imagery elaboration and self-efficacy in the covert modelling treatment of unassertive behaviour. *Journal of Consultative and Clinical Psychology*, *47*, 725–733.
Lorig, K., Chastain, R. L., Ung, E., Shoor, S., & Holman, H. (1989). Development and evaluation of a measure of perceived self-efficacy in people with arthritis. *Arthritis and Rheumatism*, *32*, 37–44.
Nunnally, J. (1978). *Psychometric theory*. New York: McGraw Hill.
O'Leary, A., Shoor, S., Lorig, K., & Holman, H. (1989). A cognitive-behavioural treatment for rheumatoid arthritis. *Health Psychology*, *7*, 527–544.
Orbell, S., Johnston, M., Rowley, D., Davey, P., & Espley, A. (2001). Self-efficacy and goal importance in the prediction of physical disability in people following hospitalisation: A prospective study. *British Journal of Health Psychology*, *6*, 25–40.
Patla, A. E., Prentice, S. D., & Gobbi, L. T. (1996). Visual control of obstacle avoidance during locomotion: Strategies in young children and older adults. In A. M. Ferrandez & N. Teasdale (Eds.), *Changes in sensory motor behaviour in aging* (pp. 257–277). North Holland: Elsevier Science.
Phillips, L. H., Kliegel, M., & Martin, M. (2006). Age and planning tasks: The influence of ecological validity. *International Journal of Aging and Human Development*, *62*, 175–184.
Potter, L. M., & Grealy, M. A. (2006). Aging and inhibitory errors on a motor shift of set task. *Experimental Brain Research*, *171*, 56–66.
Potter, L. M., & Grealy, M. A. (2008). Aging and inhibition of a prepotent motor response during an ongoing action. *Aging, Neuropsychology and Cognition*, *15*, 232–255.
Rees, D. G. (1998). *Essential statistics* (3rd ed., pp. 94–96). Boca Raton, FL: Chapman and Hall.
Schaie, K. W. (1996). *Intellectual development in adulthood: The Seattle Longitudinal Study*. New York: Cambridge Univerity Press.
Schwarzer, R. (1992). Self-efficacy in the adoption and maintenance of health behaviours: Theoretical approaches to a new model. In R. Schwarzer (Ed.), *Self-efficacy: Thought control of action* (pp. 217–245). Abington, UK: Taylor and Francis.
Schwarzer, R., & Fuchs, R. (1995). Self-efficacy and health behaviours. In M. Connor & P. Norman (Eds.), *Predicting health behaviour: Research and practice with social cognition models* (pp. 163–196). Buckingham, UK: Open University Press.
Tabachnick, B. G., & Fidell, L. S. (1996). *Using multivariate statistics*. New York: Harper and Row.
Tang, P.-F., & Woollacott, M. H. (1996). Balance control in older adults: Training effects on balance control and the integration of balance control into walking. In A. M. Ferrandez & N. Teasdale (Eds.), *Changes in sensory motor behaviour in aging* (pp. 338–367). North Holland, Amsterdam: Elsevier Science.
Tinetti, M. E., Liu, W. L., & Claus, E. (1993). Predictors and prognosis of inability to get up after falls among elderly persons. *Journal of the American Medical Association*, *269*, 65–70.
Toshima, M. T., Kaplan, R. M., & Reis, A. L. (1992). Self-efficacy expectancies in chronic obstructive pulmonary disease rehabilitation. In R. Schwarzer (Ed.), *Self-efficacy: Thought control of action* (pp. 325–354). Abington, UK: Taylor and Francis.
Vandervoort, A. A. (1992). Effects of aging on human neuromuscular function: Implications for exercise. *Canadian Journal of Sports Sciences*, *17*(3), 178–184.
Ylikoski, R., Ylikoski, A., Keskivaara, P., Tilvis, R., Sulkava, R., & Erkinjuntti, T. (1999). Heterogeneity of cognitive profiles in aging: Successful aging, normal aging, and individuals at risk for cognitive decline. *European Journal of Neurology*, *6*, 645–652.
Zacks, S. (1992). *Introduction to reliability analysis: Probability models and statistical methods*. New York: Springer.

Received 7 September 2006; revised version received 7 February 2008

20448295, 2009, 1, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1348/000712608X304478 by University Of Glasgow, Wiley Online Library on [21/12/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License