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Can subjective cognitive complaints at three months post stroke predict alteration in information processing speed during the first year?

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ABSTRACT

Cognitive impairment, particularly slowing of information processing speed (IPS), is prevalent after stroke. However, the link between subjective cognitive complaints (SCC) and cognitive deficit remains unclear. This study evaluated the link between SCC at three months post stroke and deficit as well as objective alterations in IPS in the first year post stroke. Patients (N = 200) and healthy controls (N = 105) took part in the COMPlaints After Stroke study (COMPAS). SCC, IPS and depression were evaluated at 3 months, 1 and 2 years post stroke. The Reliable Change Index was used to assess change in IPS in the first year post. Approximately one out of three patients showed deficit in IPS irrespective of time post stroke, while a change in IPS (N = 117) over time was relatively uncommon. SCC at three months post stroke did not predict change in IPS between three months and one year post stroke, where depressive symptoms did show a link. Cross sectional data showed a deficit in IPS in a substantial number of stroke patients irrespective of the point in time. Longitudinal data revealed a further decline in a small subgroup in the first year post stroke, which was not predicted by SCC at three months post stroke. The findings show that, irrespective of time post stroke and even when stroke is relatively mild, impairment in IPS is prevalent, but cannot be predicted by the complaints patients express. The link with depressive symptoms needs more exploration.

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Stroke; reliable change; information processing speed; subjective cognitive complaints; cognitive impairment

Introduction

Stroke has long-term motor and cognitive consequences and both can detrimentally affect professional (Jennum et al., 2015) and social functioning (Hommel, Miguel et al., 2009; Hommel, Trabucco-Miguel et al., 2009) as well as quality of life (Park et al., 2013). Cognitive impairment is common one year after stroke (Gottesman & Hillis, 2010) and persists over time (Douiri et al., 2013), irrespective of the age at onset (Schaapsmeerders et al., 2013) and even when deficits are relatively mild (Rasquin et al., 2004). However, long-term cognitive outcome is heterogeneous and difficult to predict. For example, Ballard et al. (Ballard et al., 2003) found that most older stroke patients (above 75 years)

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showed improved global cognitive functioning over time. On the contrary, Allen et al. (Allan et al., 2011) reported heightened risk of dementia in this patient group, with cognitive decline (executive functioning and memory), depression and (three or more) cardiovascular risk factors as predictive variables. Stroke survivors can be categorized as improvers, patients who remain stable and decliners according to how or even if their cognitive performance changes over time.

In the first weeks or months after stroke problems like aphasia and neglect as well as deficits in verbal memory and visuospatial construction tend to resolve in most patients (Gottesman & Hillis, 2010). In contrast, slowing of information processing speed (IPS) is highly prevalent (Mahon et al., 2020), frequently reported by patients (Visser-Keizer et al., 2002) and also tends to persist over time (Gottesman & Hillis, 2010; Rasquin et al., 2004; Schaapsmeerders et al., 2013). This could be due to the fact that not a specific brain structure or location, but rather a strategic brain network, namely a frontal-subcortical neuronal circuit, has been associated with IPS (Duering et al., 2013). A slowing of IPS results in everyday life routines taking more time and effort (Winkens et al., 2006), especially when they are time-pressured or consist of multiple elements (Lee et al., 2015). Slowing of IPS could also be linked to other cognitive problems (Su et al., 2015), for example: forgetting an appointment or not being able to solve a problem. This has been found in a healthy older population (age 50 to 90 years; Mougias et al., 2019), and could make it difficult for both patients and their proxies to recognize the specific underlying cognitive deficit (Winkens et al., 2006). Slowing of IPS can be evaluated by assessing objective cognitive functioning, using neuropsychological tests, or by using questionnaires and interviews focusing on subjective cognitive complaints (SCC). In general measures that evaluate SCC, the focus is on self-reported changes in functioning and quality of life (Van Rijsbergen et al., 2014). Since slowing of IPS affects other cognitive domains as well, a general measure to evaluate SCC is still useful.

The link between SCC and demographic variables, stroke related variables or cognitive impairment based on the results of neuropsychological assessment is not at all clear yet. In a review of the literature (Van Rijsbergen et al., 2014), no link was found between SCC and stroke characteristics (stroke severity, vascular risk factors) or demographic variables (age, education). On the other hand, a relationship between SCC and stroke location was reported (Liebermann et al., 2013; Narasimhalu et al., 2013), as well as a link between SCC and psychological factors, including personality, depressive symptoms and fatigue (Duits et al., 2008). With regard to IPS, Winkens et al. (Winkens et al., 2009), using newly developed tasks, found a link between an objective neuropsychological measure and a questionnaire on perceived consequences of mental slowness in stroke patients.

A slowing of IPS after stroke affects professional (Jennum et al., 2015) and social functioning (Hommel, Miguel et al., 2009; Hommel, Trabucco-Miguel et al., 2009) as well as quality of life (Park et al., 2013). Therefore, it is not only important to gain insight into the prevalence but also explore the course of recovery or even further decline over time as well. Furthermore, in several neurological populations it is suggested that SCC might function as an initial indicator of cognitive decline (Mark & Sitskoorn, 2013).

Comprehending the link between stroke related changes in IPS and SCC might help to set attainable rehabilitation goals in order to improve both functioning and quality of life of stroke survivors.

The current study explored possible links between results on "standard care" objective IPS tasks and SCC rating scales at both the cross sectional and longitudinal level. Both 1) IPS and 2) SCC as well as depressive symptoms were evaluated at three points in time after stroke. Furthermore, change over time was explored using 3) differences between patients who over time declined or remained stable. Finally 4) the link between SCC at three months post stroke and the change in IPS in the first year post stroke was evaluated. Since previous research reported that recovery takes place in the first six months after stroke (Gottesman & Hillis, 2010), the course of recovery was measured using the Reliable Change Index, where IPS assessed at three months was compared to IPS at one year post-stroke.

Methods

Participants

Both stroke patients and healthy controls were enrolled in the COMplaints After Stroke study (COMPAS; Van Rijsbergen et al., 2013). Figure 1 provides a flowchart of the patients included in this study. Diagnosis of a hemorrhage resulted in exclusion due to

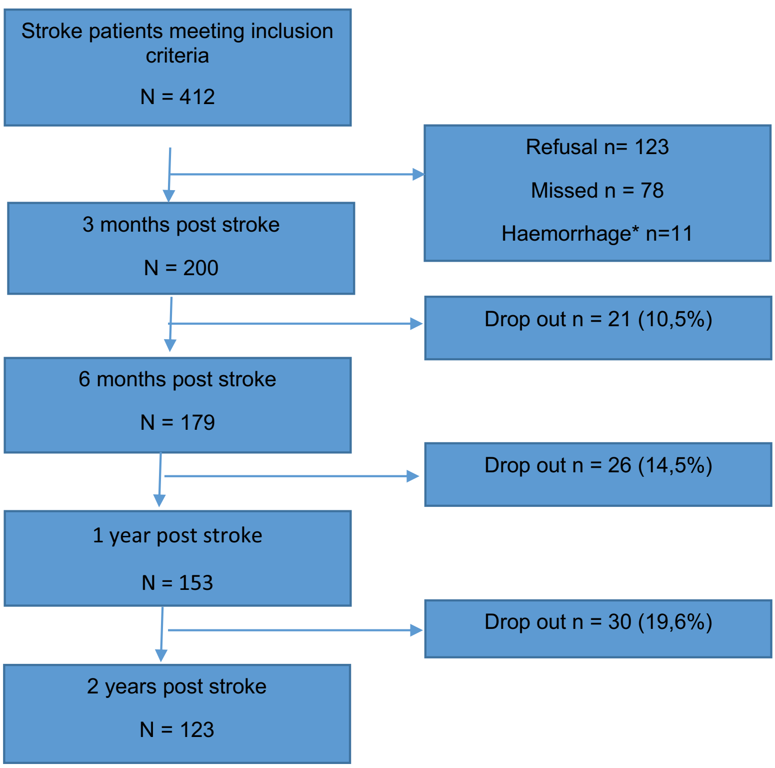

Figure 1. Flowchart of the study participants.

the small N (11). The healthy control group consisted of people who were interested and wanted to take part in the study as well as some relatives (spouses excluded) and acquaintances from the social network of participants. A total number of 200 stroke patients and 105 controls were included. Vascular risk factors, for example, a positive medical history for hypertension, obesity or diabetes mellitus, clinical stroke characteristics (e.g., stroke location, severity and recurrence) and demographic variables, such as educational level, living situation and work status, were also assessed at inclusion.

Materials

Information Processing Speed (IPS)

In accordance with clinical practice, IPS was evaluated using the following two neuropsychological tasks: the Stroop test (Stroop, 1935) and the Digit Symbol Coding (Wechsler, 2008). The Stroop test was originally developed to measure subcomponents of executive functioning (mental flexibility, interference and attention). The first card depicts the names of four colors written in black ink, the second card shows rectangles in the same four colors. In both conditions the instruction is to respond as quickly as possible by either reading out the name or naming the color. The total time in seconds to complete each card is recorded in seconds and is therefore considered a measure of IPS. A lower score (faster completion) corresponds with a better performance. Digit Symbol Coding is a subtest of the Wechsler Adult Intelligence Scale IV (Wechsler, 2008). Although originally designed to evaluate associative learning, Joy et al. (Joy et al., 2004) showed that speed plays a major role (accounts for approximately 50% of the variance) in the performance on this task. Below a list of 9 digit-symbol pairs only the digits are shown. Participants are instructed to fill out the corresponding symbols as quickly as possible in a limited amount of time (2 minutes). The total score reflects the total number of correct responses. A higher score reflects a better performance.

Subjective Cognitive Complaints (SCC)

Complaints about cognitive functioning were evaluated by using both a generic and a stroke specific questionnaire. The Dutch version of the Cognitive Failures Questionnaire (CFQ; Broadbent et al., 1982) was used to assess subjective cognitive complaints (SCC). In this scale patients are asked to answer 25 questions on the frequency of daily cognitive problems. The Check List for Cognitive and Emotional consequences-24 following stroke (CLCE; Van Heugten et al., 2007), is a structured interview, consisting of 22 standardized items (15 on cognition and 7 on emotions), to assess the complaints patients experience after stroke. Both questionnaires have proven to be both valid and useful (Van Heugten et al., 2007), while the CFQ is used in clinical practice and scientific research as well as in both patient- and healthy populations (Ponds et al., 2006).

Depression

Depressive symptoms were assessed using the Hospital Anxiety and Depression Scale (HADS; 1983). The HADS was developed to indicate the occurrence of depression and/or anxiety in a clinical setting. Research has shown that the HADS performs well in assessing the symptom severity in both somatic, psychiatric and primary care patients as well as in the general population (Bjelland et al., 2002). It contains 14 items, consists of two subscales and uses a 4 point Likert-scale. The internal consistency, as assessed by Cronbach's alpha coefficient, is 0.84 and 0.81 for subscales "Anxiety" and "Depression", respectively (Ayis et al., 2018). In this study only the subscale depression is used (7 items, maximum score = 21).

Procedure

In the COMPlaints After Stroke study (COMPAS; 2013 2013) clinical and demographic variables were collected in the acute phase after stroke, including stroke severity (National Institute of Health Stroke Scale, NIHSS; Goldstein et al., 1989), recurrence, location and side of stroke. Furthermore, the presence of vascular risk factors was registered, specifically diabetes mellitus, hypertension, smoking in the past five years, alcohol (>2 units a day) and hypercholesterolemia. Data concerning Body Mass Index (BMI) and total number of comorbidities was gathered and included in the exploratory analyses. At discharge, functional status was assessed using the Barthel Index (BI; Mahoney & Barthel, 1965). An extensive neuropsychological evaluation was performed at three months, one and two years post stroke, assessing several cognitive domains (e.g., memory, attention and executive functioning). Focus in the current study is on IPS and SCC as well as other psychological variables. The data from the 3 months and 1 year measurements were included in the present study to evaluate change in IPS. See, Table 1 for all the variables assessed.

Statistical analyses

Change in (objective) IPS was calculated in two different ways; at the group level (average change) at the three points in time (cross sectional) and at the individual level (longitudinal), in which individual data from the assessments at 3 months and 1 year post stroke was used to calculate the Reliable Change Index (RCI). Data of two years post stroke assessment was only used for exploratory purposes.

The three IPS measures (time to complete Stroop 1 and Stroop 2, total number correct at Digit Symbol Coding) were first transformed into standardized z- scores (z score = test score − norm score/standard deviation normgroup) by using published means and standard deviations (SD). For the Stroop tasks, where a higher score equals worse performance, the sign was inversed before calculating the z-score. By pooling (determining the mean) the three z-scores of every individual the IPS index was calculated. The

Table 1. Materials included in this study.

Variable	Instrument	Point in time
Demographic and clinical variables	Interview, clinical data	T0, T1
Information Processing (IPS)	Stroop card 1 and 2 Digit Symbol Coding (WAIS-IV)	T1, T3 and T4
Subjective Cognitive Complaints (SCC)	CFQ total score CLCE-24	T1, T2, T3 and T4
Depressive symptoms (covariate)	HADS subscale depression	T1 and T3

CFQ = Cognitive Failures Questionnaire, CLCE-24 = CheckList for Cognitive and Emotional consequences following stroke, HADS = Hospital Anxiety and Depression Scale. T0 = clinical phase, T1 = 3 months, T2 = 6 months, T3 = 1 year, T4 = 2 year post-stroke.

higher the index (z-score; max: 6.47), the better an individual performed, where a higher score on the SCC instruments represents more complaints. To assess change in repeated neuropsychological testing the Reliable Change Index (RCI) was calculated (Duff, 2012; Maassen et al., 2009) in order to take into account measurement errors due to practice effects and regression to the mean. McSweeney et al.'s (Maassen et al., 2009) formula, including the control group (n = 105) data, was used to determine the RCIs for the patients at three months and one year post stroke.

Based on the RCI, three different groups of patients were identified: (1) improvers – those who showed recovery in IPS (+2SD); (2) no change – those who remained stable and; (3) decliners – those who showed a significant decrease in IPS over time (−2SD). A cutoff of 2 SD reflects a clear evidence of impairment (Lezak et al., 2004) and is most often used in clinical practice. Pearson correlations were used to explore the relationship between SCC and objective performance in the groups of patients who remained stable and those who showed a decline. Statistical analyses were performed using SPSS 23.0 (2015). A *p*-value of <0.05 was defined as statistically significant.

Results

Demographic variables

The majority of stroke patients (91.5%) included in the current study scored mild to moderate on both the NIHSS stroke severity scale (ranging from 1 to 15; n = 183) and the Barthel Index at discharge from hospital (μ 18.8, SD 2.4). Demographic variables, stroke characteristics and psychological variables at three months post stroke are presented in Table 2.

Table 2. Characteristics of the stroke group.

Demographic characteristics	
Gender (male)	132 (66%)
Age in years – mean (SD/range)	65.1 (12.2/23.6–95.6)
Education	
Low	37
Average	106
High	57
Stroke Characteristics	
First ever stroke	180 (90%)
Stroke side	
Left	75 (37.5%)
Right	99 (49.5%)
Both/diffuse	26 (13.0%)
NIHSS – mean (SD)	3.9 (3.5)
NIHSS 0	13 (6.5%)
NIHSS 1–4	133 (66.5%)
NIHSS 5–15	50 (25%)
NIHSS >16	4 (2.0%)
Barthel Index at discharge – mean (SD)	18.8 (2.4)
Psychological variables	
HADS – depression – mean (SD/range)	5.12 (3.73/0-21)
Depressive symptoms (HADS-D > 7)	51 (25.5%)

Education; low = primary school or less, average = secondary school and secondary vocational education, high = higher vocational education and university; NIHSS = National Institute of Health Stroke Scale (0–42); Barthel Index (0–20). HADS = Hospital Anxiety and Depression Scale.

Dropouts versus completers

Figure 1 shows the drop out over time. The total drop out by the end of the study was 40%. No significant differences between dropouts and completers were found on: demographic variables, the total number of vascular risk factors, clinical stroke characteristics or IPS scores at the first neuropsychological evaluation at three months post stroke (−1.48 (1.52) vs. −1.14 (1.45); F(1.190) = 1.879. p = .172). Drop outs and completers did differ on the Barthel Index at discharge from hospital (lower in dropouts, p = 0.04) and hypertension (more patients in the dropout group had hypertension, p = 0.04).

Information Processing Speed

Table 3 depicts the means and SD's on the three IPS tasks for the whole study period after transforming the scores into z-scores. For every stroke patient who completed both Stroop Card 1 and 2 and Digit Symbol Coding task (n = 147) at the 3 month and one year assessment, the RCI in IPS over this period was calculated. A RCI between −1.645 and 1.645 represents no significant change. Overall, IPS is impaired (2SD below average) in respectively 29.7%, 29.9% and 36.7% of the patients at three months, one and two years post stroke. The scores at two years post stroke were significantly lower than at one year post stroke (F (1.95) = 5.901. p = 0.017), resulting in an increased proportion of patients with impaired IPS (36.7%).

Table 3. Mean, standard deviation and range of the different tasks and the calculated information processing speed index score in z-scores at 3 months, 1 and 2 year post stroke.

	Three months N = 200	1 year N = 153	2 year N = 123
Digit Symbol Coding			
N	198	146	99
Mean (SD)	−3.00 (2.33)	-.53 (1.10)	-.54 (1.15)
range	-.76/1.19	-3.00/-2.33	-3.00/-2.00
% impairment	24.7%	16.4%	17.2%
Stroop Card 1			
N	194	144	99
Mean (SD)	−1.74 (2.08)	−1.92 (2.17)	−2.40 (2.34)
range	-13.21/- 1.19	-12.77/-1.34	-11.32/-1.12
% impairment	39.7%	44.4%	53.5%
Stroop Card 2			
N	193	144	98
Mean (SD)	−1.16 (1.89)	−1.24 (1.98)	−1.49 (1.93)
range	-12.17/-1.63)	-12.17/-2.49	-6.89/-1.07
% impairment	29.0%	27.8%	34.7%
IPS index-score			
N	192	144	98
Mean (SD)	−1.22 (1.47)	−1.23 (1.50)	−1.49 (1.56)
range	-7.35/-1.32	-6.46/-1.34	-6.61/-.91
% impairment	29.7%	29.9%	36.7%

*significant at p = 0.05 level; ** significant at p = 0.01 level
SD = Standard Deviation; IPS = Information Processing Speed

Subjective Cognitive Complaints

All stroke patients scored below the cutoff score of the CFQ (cut off ≥44) at all points in time. Nevertheless, approximately 80% of the patients reported at least one hindering cognitive complaint at all time-points (77.4% at three months, 76.6% at one and 78.3% at two years post stroke). Most patients reported two hindering cognitive complaints (range 0–9) on the CLCE. When exploring the link between SCC and IPS-scores, the CLCE scores were significantly and negatively associated with IPS scores at three months ($r = -0.261$, $p < .01$) and one year ($r = -3.00$, $p < .01$) post stroke in contrast to the CFQ scores, which did not correlate with IPS scores at any point in time. To evaluate the associations between change in IPS and SCC in the total group bivariate Pearson correlations were calculated at the different time points. Significant and negative associations were found at three months and one year post stroke for both questionnaires (CFQ $r = -0.161$, $p < 0.01$ and $r = -0.241$, $p < 0.01$; CLCE $r = -0.173$, $p < 0.05$ and $r = -0.228$, $p < 0.01$).

Depressive symptoms

25% of the patients reported depressive symptoms (HADS-D > 7) at three months post stroke (see, Table 2). Furthermore, at three months and one year post stroke depressive symptoms were weakly and negatively correlated with IPS (at three months $r = -0.192$, $p = 0.013$ and at one year $r = -0.191$, $p = 0.035$) and moderately and negatively associated with both CFQ and CLCE (correlations between $r = 0.381$ and -0.578, $p < .01$). Depressive symptoms at one year were significantly associated with reliable change in IPS ($r = -0.190$, $p < 0.05$).

Decliners versus patients who remained stable

RCIs were calculated and three groups were identified: decliners (N = 26), patients who remained stable (N = 117) and improvers (N = 4). Figure 2 shows the course of IPS over time for the three groups. The small group of improvers (less than 3%) was excluded from further analysis. Demographic variables and stroke characteristics did not differ significantly between decliners and patients who remained stable. Decliners tended to report more SCC (at all three points in time) than patients who remained stable, but when repeated measurement MANOVA was performed no significant effect of group was found. Exploring the data at two years post stroke showed that both groups reported more SCC compared to the previous measurements, but no significant increase over time was found. Between groups there was no time effect. Patients who showed decline in IPS scored higher on depressive symptoms one year post stroke ($t\ (121) = 2.06$; $p = 0.042$) compared to patients who remained stable. Furthermore, work status was marginally associated with reliable change in IPS ($phi = 0.146$, $p = 0.09$).

Predictors of reliable decline in processing speed

Logistic regression models were used to evaluate if SCC at three months predicted decline in IPS over the first year post stroke. Two separate analyses were carried out for the two SCC questionnaires. In the first step only SCC at three months were included as

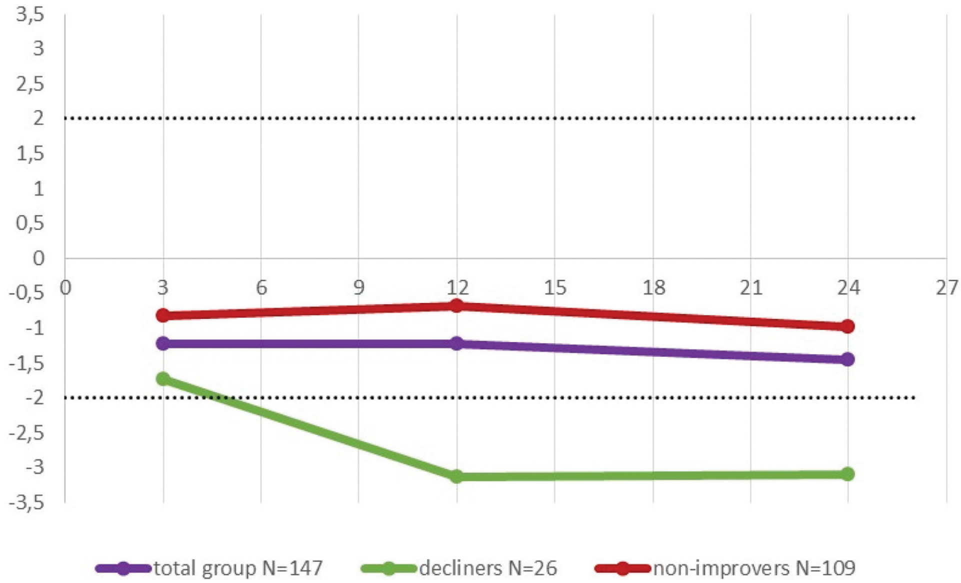

Figure 2. Mean scores of information processing speed index for the total group, decliners and patients who remained stable.

a predictor in the model. In the second step the model was adjusted for depressive symptoms at three months. From the demographic variables only work status was marginally associated with reliable change in IPS (phi = 0.146, $p = 0.09$) and was therefore additionally entered in the last step as a predictor. The assumption of multi-collinearity was not violated ($r < 0.6$). None of the models was significant at the $p = 0.05$ level and the combination of entered variables could not predict decline in IPS (CFQ: Model 1: R2 (Nagelkerke) = 0.038, $p = 0.086$, model 2: R2: 0.041, $p = 0.203$, Model 3: R2 = 0.080, $p = 0.096$/CLCE: Model 1: R2 (Nagelkerke) = 0.036, $p = 0.093$, Model 2: R2 (Nagelkerke) = 0.043, $p = 0.187$, Model 3: R2 (Nagelkerke) = 0.084, $p = 0.08$).

Discussion

SCC reported by patients at three months post stroke did not predict decline in IPS during the first year. Nevertheless, approximately one out of three patients showed a deficit in IPS irrespective of time post stroke, even when, as is the case here, stroke is considered to be mild. Furthermore, over 80% of the population showed a decline in IPS or remained stable. This underlines the fact that IPS performance in our stroke patients was lower compared to an age-matched norm group and that it remained at this level or declined over time. Finally, the proportion of stroke patients with impaired IPS slightly increased over time. SCC assessed by a structured interview (CLCE) were associated with deficit in IPS at 3 months and 1 year post stroke. At the individual level, patients who showed a decline in IPS reported more SCC on the structured interview as well as on the rating scale (CFQ) at both 3 months and 1 year post stroke, compared to patients who remained stable. However, a group effect was not found.

Deficit in IPS after stroke (approximately 30% at all points in time) in this study is in general agreement with previous research (Gottesman & Hillis, 2010; Moran et al., 2014), despite differences in study populations as well as methodological (neuropsychological tasks) and statistical variables (cutoff point in determining cognitive impairment, Reliable Change Index formula) between studies. The total number of SCC remained high over time and although decliners tended to report more SCC at all time points, no group effect was found. This could be due to the relatively small number of participants as well as to the transformation of data into z-scores to determine deficit in IPS, restricting the range of scores. Furthermore, it is important to note that in both questionnaires not only IPS but other cognitive domains (for example, attention and executive functioning) are addressed as well. Nevertheless, IPS scores at three months and one year post stroke were significantly associated with CLCE scores, but not with CFQ scores. The CFQ is a rating scale in which patients are asked to report the complaints they experience, while the CLCE is a structured interview performed by a trained examiner with topics that are stroke specific. Although widely used in clinical practice, self-report questionnaires might result in a underestimation of the problems in cognitive functioning due to consequences of stroke such as a lack of awareness or change in cognitive functioning (deficits of magnitude estimation, pathologic alteration of self-awareness, alteration in distributed cortical systems supporting emotional semantics and abstraction; Barrett, 2010). This implies that the CLCE is the preferred instrument to assess cognitive complaints in clinical stroke practice, which is in accordance with earlier work (Van Heugten et al., 2007; Van Rijsbergen et al., 2015).

Other variables which have been linked with IPS impairment in the literature were also explored, namely: demographic variables (Mahon et al., 2020; Schaapsmeerders et al., 2013), stroke characteristics (Gerritsen et al., 2003; Schaapsmeerders et al., 2013), vascular risk factors (Mahon et al., 2020) and depressive symptoms (Terroni et al., 2012). Decliners (versus those who stayed stable on IPS) were more depressed at 1 year post stroke. However, depressive symptoms at 3 months could not predict decline in IPS at one year post stroke at group level. Due to the study design it is not possible to make causal inferences about the link with depression: slowed IPS could be a consequence of depressed mood but on the other hand depressive symptoms could be a reaction to perceived slowness in daily life. A trend was observed concerning work status; patients who had returned to work at three months post stroke were less likely to show a decline in IPS at one year post stroke. This is in agreement with Fride et al. (Fride et al., 2015) who found that that patients who returned to work (compared to those who did not) scored better on measures of cognition, mood and quality of life. The authors argued that factors such as performing more complex tasks, having structure during the week and feeling re-integrated into the community might contribute to this positive effect.

The current longitudinal study has a number of strengths and limitations. To our knowledge the use of a regression based reliable change index using control group scores to evaluate the development of cognitive deficit over time has not often been used before in a stroke population. Furthermore, while patients who dropped out of the study had lower Barthel Index scores at discharge (suggesting lower Activities in Daily Living functioning) compared to participants, no other major differences (e.g., demographic variables, total number of vascular risk factors, clinical stroke characteristics or results on neuropsychological assessment at 3 months post stroke) were found. The participants are therefore representative of a well-functioning stroke group. At the individual level drop-outs scored lower on IPS tasks. This might lead to an underestimation of the prevalence of deficit in IPS in this study population, consequently compromising the generalizability of the results. Furthermore, in the current study the focus was on IPS, while there are other cognitive domains (e.g., attention and executive functioning) that play an important role in professional and social functioning as well. In future research it is important address these aspects of cognitive functioning. Moreover, it is important to establish a standardized definition of cognitive impairment, in order to reduce the variation across studies in defining cognitive impairment (Gottesman & Hillis, 2010). In addition, in contrast to other studies using a cutoff of 1.5SD (Duits et al., 2008; Schaapsmeerders et al., 2013), the current study defined impairment as a 2SD deviation of the mean. This is conventional in clinical neuropsychological practice (Lezak et al., 2004) in order to reduce the effect of the substantial overlap in test results between patients and healthy people (Harvey, 2012). However, this might contribute to an underestimation of the prevalence of deficit in IPS. Finally, in this study population, stroke was relatively mild, patients showed a favorable functional outcome and were not institutionalized, compromising generalizability to the stroke population as a whole.

To conclude, the current study found that slowing of IPS is common in stroke, remains at this level or IPS even deteriorates over time. This implies that many stroke patients (over 80%) do not perform conform age-matched norms. This might result in impairments in daily functioning, especially when performing tasks with time-pressure or keeping up with a conversation. We recommend routinely assessing IPS both immediately after a stroke and at follow up. Ideally, a stroke-specific instrument (e.g., the CLCE) to assess SCC should also be routinely used as part of the neuropsychological evaluation. Both will contribute to identify stroke patients at risk for experiencing cognitive disabilities. This will enable providing tailor-made psycho-education and suitable compensating techniques. In addition, it will contribute to formulating realistic and attainable rehabilitation goals as well as expectations about (cognitive) functioning in the future. Ultimately this will promote the quality of life of stroke patients and their proxies.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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