

## Evaluating the Validity and Reliability of the Korean Version of Upper Extremity Performance Test for the Elderly (TEMPA)

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### Abstract

**Objective** : This study aimed to verify the validity and reliability of the Upper Extremity Performance Test for the Elderly (TEMPA) by modifying its items 새 exhibit cultural differences.

**Methods** : This study included 171 healthy adults and older adults and 41 individuals with impaired upper extremity function. Content validity, discriminant validity, test-retest reliability, and inter-rater reliability were analyzed.

**Results** : The following items, exhibiting cultural differences, were modified: “open a lock and take the top off a pillbox” and “write and affix a postage stamp.” The discriminant validity results indicated that participants with normal upper extremity function performed better than those with impaired in the upper extremity function ( $p < .001$ ). The test-retest reliability of the execution speed (intraclass correlation coefficient: ICC) was .71-.94, functional rating (kappa) was 1.0, and task analysis (ICC) was 1.0. The inter-rater reliability of the speed of execution was 1.0, functional rating was .79-1.0, and task analysis was .94-1.0.

**Conclusion** : TEMPA has moderate to high level of reliability and is an assessment tool that can clearly distinguish individuals with upper extremity impairment from those without impairment.

**Key Words** : Hand Functions, Older adults, Reliability, TEMPA, Validity

## I. Introduction

Upper extremity function is an essential function of the human body. Impairment in the upper extremity function reduces an individual's ability to perform the activities of daily living (ADLs) and instrumental activities of daily living (IADLs) (Ranganathan, Siemionow, Sahgal, & Yue, 2001; Vliet, Van der Wijk, Jolie, Zwiderman, & Hazes, 1996; Kim, 2008). This leads to a decrease in occupational performance and independence, as well as quality of life (Carroll, 1965; Pendleton & Schultz-Krohn, 2013; Radomski & Latham, 2013). Additionally, impaired upper extremity function is associated with decline in cognitive function (Ogata, Kato, Honda, & Hayakawa, 2014). Therefore, it is crucial to accurately assess patients with upper extremity impairments to ensure that the appropriate rehabilitation program is implemented (Desrosiers, Hébert, Dutil, & Bravo, 1993).

The precise assessment of upper extremity function is obtained by evaluating the older adults' performance level of everyday activities (Jacobson-Sollerman & Sperling, 1976; Jebsen, Taylor, Trieschman, Trotter, & Howard, 1969). Unlike activities measuring separate hand functions, such as moving a wood block or picking up pegs to place them in holes, diverse and complex hand functions can be assessed through performance of ADLs (Desrosiers et al., 1993). Moreover, precise evaluation of upper extremity function can be obtained through time-based assessment (e.g., performance speed assessment) and qualitative measurement (e.g., quality of movement and functional ability measurement) (Kopp et al., 1997; Lemmens, Timmermans, Janssen-Potten, Smeets, & Seelen,

2012). Using both quantitative and qualitative assessment methods, comprehensive collection of diverse upper extremity data can be performed.

Upper Extremity Performance Test for the Elderly (Test Evaluant les Membres supérieurs des Personnes Agees; TEMPA) is an assessment tool that fulfills the following criteria for optimal data evaluation: It enables the measurement of diverse and complex upper extremity functions through performance of ADLs (e.g., opening a jar and pouring water) and allows the quantitative and qualitative assessment of overall function (Desrosiers et al., 1993). Hence, an assessment tool that can accurately evaluate upper extremity function is greatly needed in the clinical setting. Unfortunately, TEMPA has not been introduced in Korea. Several upper extremity assessment tools can be used to measure ADL performance (Lemmens et al., 2012): Arm Motor Ability Test (AMAT), Frenchay Arm Test (FAT), TEMPA, and Jebsen-Taylor Hand Function Test (JTHFT). Among those tools, the JTHFT is commonly used in Korea (Lee & Jung, 2015). In addition, AMAT, TEMPA, Motor Evaluation Scale for Upper Extremity Stroke Patient, and Manual Function Test (MFT) are upper extremity assessment tools that can provide both quantitative and qualitative measurements. However, only MFT is frequently used (Lemmens et al., 2012; Yoo, Jung, Park, & Choi, 2006; Lee & Jung, 2015). In Korea, only a few available assessment tools have been used to evaluate the overall upper extremity function. Therefore, additional assessment tools are needed to evaluate ADL performance and obtain quantitative and qualitative measurements in older adults.

TEMPA was developed for the older adult patients of North America. The cultural traits of

Koreans must be taken into consideration prior to the implementation of TEMPA in Korea. Therefore, this study aimed to measure the construct validity of TEMPA usage in Korean clinics and modify the assessment tool in accordance with the Korean culture. It also aimed to verify the validity and reliability of the modified TEMPA when used in the Korean clinical setting to evaluate upper extremity function.

## II. Methods

### 1. Participants

A total of 212 individuals, 171 younger and older adults without upper extremity impairment and 41 younger and older adults with upper extremity impairment, were recruited in the study (Table 1, 2). Individuals (1) without neurological and musculoskeletal deficits that affect upper extremity function, (2) without cognitive impairment, and (3) without comprehension difficulties in following instruction during evaluation constituted the healthy

group. By contrasts, individuals (1) exhibiting one or several neurological and musculoskeletal deficits affecting upper extremity function, (2) exhibiting deficits affecting upper extremity function for over 3 months, (3) without cognitive impairment, and (4) without comprehension difficulties in following instruction during evaluation constituted the impaired group. Only participants who meet the inclusion criteria, through a brief interview, were informed about the purpose and process of the assessment. The data were collected through continuous sampling. This study was approved by institutional review boards at Yonsei University and a written informed consent was obtained from all participants.

### 2. Measures

TEMPA was developed by Desrosiers et al. (1993) to assess upper extremity performance of older adults in Canada. The tool is used to evaluate an older adult's performance of nine tasks (four unilateral and five bilateral tasks) selected through task analysis of daily activities. Each task is evaluated by three sub-scores: speed of execution, functional

**Table 1. Demographic Information of Participants**

(N =212)

		Healthy group (N=171)	Impaired group (N=41)
		N (%)	N (%)
Gender	Male	83(48.5)	22(53.7)
	Female	88(51.5)	19(46.3)
Ages	40-49	32(13.3)	2(4.9)
	50-59	36(14.9)	6(14.6)
	60-69	36(14.9)	13(31.7)
	70-79	32(13.3)	9(22.0)
	80 and over	35(14.5)	11(26.8)
Dominant hand	Right handed	166(97.1)	41(100.0)

**Table 2. Types of Impairments, Duration, and Gender**

(N= 41)

	Average disease period (m)	Gender		Total N (%)
		Male N (%)	Female N (%)	
Hemiplegia	43.9	14(34.2)	5(12.2)	19(46.3)
Diplegia	48.0	1(2.4)	1(2.4)	2(4.9)
Rheumatoid arthritis	132.0	0(0.0)	4(9.8)	4(9.8)
degenerative arthritis	150.0	0(0.0)	2(4.9)	2(4.9)
Tremor	210.0	3(7.3)	1(2.4)	4(9.8)
Carpal Tunnel Syndrome	12.5	0(0.0)	2(4.9)	2(4.9)
Hand or finger amputation	297.6	3(7.3)	2(4.9)	5(12.1)
Shoulder Impingement Syndrome	6.0	0(0.0)	1(2.4)	1(2.4)
Scapular amputation	720.0	1(2.4)	0(0.0)	1(2.4)
Elbow deformity	360.0	0(0.0)	1(2.4)	1(2.4)
Total	126.8	22(53.7)	19(46.3)	41(100)

rating, and task analysis. Speed of execution measures the amount of time spent for an individual to complete each task. For each item, every individual has a limit of 120 seconds. *Functional rating* measures how the individual successfully and easily performs the tasks. In the *task analysis*, the upper extremity performance is measured by five variables: range of movement, strength, control of gross movement, prehension patterns, and fine movement, related to basic neurosensorimotor skills of the upper extremities. Both *functional rating* and *task analysis* have a four-point system, ranging from 0 to -3. In the precedent analysis of 29 participants aged 60 years and older, the intraclass correlation coefficients (ICC) of TEMPA was .70 to 1.0, and the concurrent validity was .73 to .95 (Desrosiers et al., 1993; Desrosiers, Hebert, Dutil, Bravo, & Mercier, 1994b).

### 3. Procedures

Content validity was verified by a committee

consisting of four professors who are experts in the field of occupational therapy. To verify content validity, the content validity index (CVI) calculation method was used (Polit, & Beck, 2006). Discriminant validity was verified by comparing the results of the impaired group and the healthy group. The comparison experiment was conducted separately for the dominant hand and the non-dominant hand. Among the impaired group, the affected and impaired side was considered as the non-dominant hand, while the intact side was considered as the dominant hand. Types of impairment are listed in Table 3.

Test-retest reliability was assessed in 25 participants from the healthy group. After 2-3 weeks, TEMPA was administered to the same group of participants for a second time. Video analysis was used to verify inter-rater reliability. There were two raters who were occupational therapists, and their results were compared to calculate the inter-rater reliability. Prior to the data collection, both raters were trained on how to use the TEMPA through sufficient mockup tests. One therapist assessed the

**Table 3. Procedures of the Study**

Validity	Content validity	1 <sup>st</sup> verification	CVI calculated by committee
		Tasks modified	Modified two tasks: "Open a lock and take the top off a pillbox", and "Write and affix a postage stamp"
		2 <sup>nd</sup> verification	CVI calculated by committee
Reliability	Discriminant validity		171 participants without impairment 41 participants with impairment
		Test-retest reliability	25 participants without impairment
	Inter-rater reliability		25 participants without impairment 10 participants with impairment

participants face to face and simultaneously recorded videos of the participants' performance. Another therapist performed assessments while watching the videos of the participants' performance from an isolated space. The original TEMPA developer provided the full permission for this study.

#### 4. Analysis

Descriptive statistic was used to analyze demographic information of participants. CVI was a 5-point scale ranging from 1 to 5, and the results of each task were calculated using the geometric mean method. Then, each score was converted to a 5-point scale ranging from 0 to 1. The score of "5" was converted to 1, "4" to 0.75, "3" to 0.5, "2" to 0.25, and "1" to 0; in this study, the cut-off score was 1.0. Among the results of the discriminant validity, the result of the speed of execution was analyzed using an independent t test, and the chi-square test was used to analyze functional rating and task analysis. In the reliability study, ICC was used to analyze the speed of execution and functional rating. For task analysis, kappa index

was used. Results of this study were analyzed using SPSS (win 21.0).

### III. Results

#### 1. Content validity

In the results of the first content validity verification by the committee, "open a lock and take the top off a pillbox" and "write and affix a postage stamp" showed .31 and .06, respectively. "Open a lock and take the top off a pillbox" had a low content validity because of cultural and experiential differences. The pillbox opens when the arrows are lined up, but this pillbox is not used in Korea. The participants were not familiar in using this type of pillbox, the arrows were marked with red tape to be more recognizable, and participants were instructed in how to open the pillbox before the test. "Write and affix a postage stamp" was modified for cultural and linguistic reasons. In the original version, all participants were asked to write words that are related to the name of their country (i.e., "Bell Canada") during the tasks. In this study, all

participants were requested to write their country name, “대한민국,” which is Korea in Korean. After modifying these items, content validity index of all items showed 1.0 in the second verification; hence, the content validity of TEMPA was established.

## 2. Discriminant validity

The quantitative and qualitative results of TEMPA between the healthy and impaired groups were compared (Table 4). As regards *speed of execution*, a quantitative assessment, the healthy and impaired groups took  $124.35 \pm 35.04$  seconds and  $218.89 \pm$

**Table 4. Comparison Result of Speed of Execution and Functional Rating Between Two Groups**

(N=212)

Tasks	Speed of execution			Functional rating			
	Healthy group (N=171)	Impaired group (N=41)	p	Healthy group (N=171)	Impaired group (N=41)	p	
	M(SD)	M(SD)		M(SD)	M(SD)		
Pick-up and move a jar	Dominant handed / Intact side	1.13 (0.37)	4.14 (17.28)	.24	0.00 (0.00)	-0.26 (0.61)	.00***
	Non-dominant handed / affected side	1.19 (0.39)	7.09 (24.09)	.10	0.00 (0.00)	-0.21 (0.59)	.00***
Open a jar and take a spoonful of coffee		9.32 (3.08)	14.27 (6.49)	.00***	-0.01 (0.08)	-0.21 (0.41)	.00***
Pour water from a pitcher into a glass	Dominant handed / Intact side	10.18 (2.50)	16.26 (16.08)	.01*	0.00 (0.00)	-0.30 (0.75)	.00***
	Non-dominant handed / affected side	9.83 (2.34)	19.19 (22.07)	.01**	0.00 (0.00)	-0.23 (0.60)	.00***
Open a lock and take the top off a pillbox		14.21 (4.43)	23.85 (18.05)	.00***	-0.02 (0.13)	-0.32 (0.59)	.00***
Write and affix a postage stamp		17.12 (8.74)	31.13 (20.96)	.00***	-0.03 (0.17)	-0.32 (0.59)	.00***
Put a scarf around one's neck		8.68 (5.17)	13.73 (11.18)	.00**	0.00 (0.00)	-0.11 (0.37)	.00**
Shuffle and deal cards		18.43 (6.22)	29.80 (17.15)	.00***	-0.04 (0.18)	-0.34 (0.64)	.00***
Use coins	Dominant handed / Intact side	8.37 (2.02)	13.57 (16.66)	.04*	0.00 (0.00)	-0.21 (0.59)	.00***
	Non-dominant handed / affected side	8.53 (1.96)	17.82 (22.79)	.00**	-0.01 (0.08)	-0.28 (0.71)	.00***
Pick up and move small objects	Dominant handed / Intact side	8.55 (3.00)	12.12 (5.12)	.00***	-0.01 (0.11)	-0.15 (0.42)	.00**
	Non-dominant handed / affected side	8.81 (2.78)	17.83 (22.66)	.00**	-0.01 (0.11)	-0.19 (0.54)	.00***
Total		124.32 (35.04)	217.79 (146.43)	.00***	-0.12 (0.50)	-3.09 (4.78)	.00***

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

**Table 5. Comparison Result of Task Analysis Between Two Groups**

(N=212)

Items	Healthy group (n=171)	Impaired group (n=41)	p
	M(SD)	M(SD)	
Range of movement	0.00(0.00)	-0.94(0.94)	.00***
Strength	0.00(0.00)	-0.15(0.42)	.00***
Control of gross movement	0.00(0.00)	-1.43(3.07)	.00***
Prehensions patterns	-0.09(0.34)	-1.98(3.45)	.00***
Fine movement	-0.20(0.45)	-1.68(3.26)	.00***
Total	-0.29(0.65)	-6.17(10.53)	.00***

\*p<.05, \*\*p<.01, \*\*\*p<.0

158.57 seconds, respectively, to complete all tasks. The performance speed of the impaired group were slower than that of the healthy group, and the difference was statistically significant (p<.001). The results of the *speed of execution* showed that the

healthy group competed all tasks faster than the impaired group, except the “pick-up and move a jar” task, and the difference was statistically significant (p<.05). As regards *functional rating* (Table 4) and *task analysis* (Table 5), the healthy group dis-

**Table 6. Reliability of TEMPA in Speed of Execution, Functional Rating**

Tasks	Test-retest (n=25)		Inter-rater (n=35)	
	Speed of execution	Functional rating	Speed of execution	Functional rating
	ICC	Kappa	ICC	Kappa
Pick-up and move a jar	Dominant handed / Intact side	.83	1.0	1.0
	Non-dominant handed / affected side	.82	1.0	1.0
Open a jar and take a spoonful of coffee		.84	1.0	1.0
Pour water from a pitcher into a glass	Dominant handed / Intact side	.71	1.0	.85
	Non-dominant handed / affected side	.74	1.0	1.0
Open a lock and take the top off a pillbox		.83	1.0	1.0
Write and affix a postage stamp		.94	1.0	1.0
Put a scarf around one's neck		.83	1.0	1.0
Shuffle and deal cards		.88	1.0	1.0
Use coins	Dominant handed / Intact side	.87	1.0	.79
	Non-dominant handed / affected side	.82	1.0	1.0
Pick up and move small objects	Dominant handed / Intact side	.79	1.0	1.0
	Non-dominant handed / affected side	.81	1.0	.85
Total		.94	1.0	.79

played better performance in both tasks and overall performance compared with the impaired group, and the differences were statistically significant ( $p < .001$ ).

### 3. Test-retest reliability

With regard to test-retest reliability, the correlation coefficient for *speed of execution* of all items was .94 and that of each item was .71 to .94 (Table 6). With regard to *functional rating*, the kappa of all items and each item were 1.0. With regard to *task analysis*, the correlation coefficient for all items and each item were both 1.0 (Table 7).

### 4. Inter-rater reliability

The correlation coefficients for speed of execution of all items and each item were all 1.0 (Table 6). This table also showed that the kappa for all items was .79 and that for each item was .79 to 1.0. Table 7 showed that the correlation coefficient in *task analysis* for all items was 1.0 and that for each item was .94 to 1.0.

## IV. Discussion

This study aimed to verify the validity and reliability of TEMPA. Through the content validity verification process, two items of TEMPA were modified due to cultural differences in experiences and language. The result of the discriminant validity test indicated that TEMPA is an assessment tool, which can clearly distinguish individuals with upper extremity impairments from those without impairments. The reliability test result showed that TEMPA has a moderate to high test-retest reliability score and moderate to high inter-rater reliability score.

In the content validity verification, “write and affix a postage stamp” item was modified to be written as “대한민국,” which stands for “Korea” in Korean, instead of writing “Bell Canada.” Since Koreans have their own language, and “대한민국” is the term that everyone is familiar with if they are Korean. There would be a difference between writing “Bell Canada” and “대한민국,” but the difference does not affect this study because the study was conducted among Korean participants only. This item modification can reduce errors, which can be caused from cultural differences, in the interpretation of research findings (Gonzalez-Calvo, Gonzalez, & Lorig, 1997).

In construct validity, convergent and discrim-

**Table 7. Reliability of TEMPA in Task Analysis**

Items	Test-retest ( $n=25$ )	Inter-rater ( $n=35$ )
	ICC	ICC
Range of movement	1.0	1.0
Strength	1.0	.94
Control of gross movement	1.0	1.0
Prehensions patterns	1.0	.99
Fine movement	1.0	.98
Total	1.0	1.0



inant validity are essential components (Brown, 2010). However, since previous studies only reported construct validity of TEMPA (Desrosiers, Bravo, Hebert, Dutil, & Mercier, 1994a; Feys, Duportail, Kos, Van Aschand, & Ketelaer, 2002), this study investigated discriminant validity (able to differentiate one from another) of TEMPA. According to the discriminant validity test result, TEMPA could distinguish the impaired participants from the healthy group participants by collective judgments through quantitative and qualitative assessments. For the quantitative assessment, the results for the *speed of execution* showed that eight items, apart from the “pick-up and move a jar” item, were different between the impaired group and healthy group. In the qualitative assessment, results of the functional rating and *task analysis* differentiated between the two groups in all tasks. In other words, this tool supplements the shortcomings of determining the difference between the two groups by using two assessment methods quantitative and qualitative, rather than using only one method.

Reliability of the modified TEMPA reports similar reliability level with the original TEMPA in both test-retest and inter-rater reliabilities (Desrosiers et al., 1993). However, the reason it showed a high test-retest reliability in the functional rating and task analysis was that there was a ceiling effect due to the characteristics of the participants. We could not find impaired functions in functional rating and task analysis data, because we could only collect the data of the participants from the healthy group. Moreover, in the verification of inter-rater reliability, participants were not only from the impaired group but also from the healthy group, making the ceiling effect highly plausible in this study.

Therefore, a future study is warranted to verify the reliability of TEMPA in examining participants with impairments in the upper extremity.

There is a limitation in this study. The results may not be generalized because the participants were recruited by non-random sampling. We could not control education level and vocational factors, which might affect the results of upper extremity function evaluation.

## V. Conclusion

We modified the TEMPA according to cultural difference and verified the reliability and validity of TEMPA. The results of our study indicated that TEMPA can be used to obtain more detailed information of the participants' upper extremity functions. Using both qualitative and quantitative assessment methods, more precise outcomes and robust comprehension can be obtained. Through quantitative measurement, we gained objectivity in client evaluation. Through qualitative assessment, we gained an open comprehension of the client's quality of movement, movement patterns, and compensation. The combined effect of both methods balances the interpretation of results and reduces biases in analyzing the outcome. We hope TEMPA is used more frequently and broadly in research and clinical situations in Korea.

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## 한국판 TEMPA의 신뢰도 및 타당도 연구

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**목적** : 본 연구는 문화적 차이를 보이는 Upper extremity performance test for elderly (TEMPA)를 한국판으로 수정 및 번역하고 그 타당도 및 신뢰도를 검증하는 것이다.

**연구방법** : 연구대상자는 40세이상의 손 기능에 장애가 없는 성인 171명과 손 기능에 장애가 있는 성인 41명 이었다. 내용 타당도와 분별 타당도를 검증하였고, 검사-재검사 신뢰도와 검사자 간 신뢰도를 검증하였다.

**결과** : 내용 타당도를 통해 문화적 차이를 보이는 2개의 항목 ('자물쇠 열고 약통 열기', '편지 봉투 작성하고 우표 붙이기')을 수정하였다. 분별 타당도를 통해 TEMPA는 손 기능에 장애가 있는 성인과 없는 성인을 구별할 수 있는 평가 도구임을 확인 하였다 ( $p < .001$ ). 신뢰도 검증 결과 수행 속도는 급간 내 상관계수 (ICC) = .71-.92, 기능 정도는 카파계수 (kappa) = 1.0, 수행 분석은 ICC = 1.0로 중간수준에서 높은 수준의검사-재검사 신뢰도를 보였다. 검사자 간 신뢰도는 실행 속도 ICC = 1.0, 기능 정도 kappa = .79-1.0, 수행 분석 ICC = .94-1.0으로 상당한 수준에서 높은 수준의 신뢰도를 보였다.

**결론** : TEMPA는 손 기능의 장애가 있는 성인을 구별해 낼 수 있고, 높은 수준의 신뢰도를 보이는 평가 도구로 임상적 평가 및 근거 기반의 연구에 있어 많이 사용되기를 기대한다.

**주제어**: 노인, 손 기능, 신뢰도, 타당도, TEMPA