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RESEARCH
ARTICLE

An Attempt to Adapt the NEEL Language Test Battery to the Algerian Context for Children Aged 4 to 6 Years

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Abstract

This article discusses the main steps involved in the attempt to adapt the NEEL test by Claude Chevrie-Muller and Monique Plaza, which is used to assess language abilities.

The tool is a battery designed for specialists in speech and language disorders, aiming to evaluate children's linguistic abilities and their proficiency in language use. It is a verbal, performance-based, and linguistic test that enables a comprehensive examination of language components.

Finally, the article presents the findings of the adaptation process, which aimed to verify the psychometric properties of the adapted version for the Algerian context. The results indicate that the test meets the established standards for test design, particularly in terms of validity and reliability.

Before presenting the results, the article addresses key theoretical concepts related to test adaptation, language, and the notion of adaptation in psychometric assessments.

1. Introduction:

Many researchers in the fields of psychology and orthophony tend to apply tests and assessment tools imported from foreign environments and Western cultures, which differ significantly from the Algerian context in terms of culture, customs, and traditions. These instruments are often employed without modification or review to suit the new environment (Jaballah Youssef, p. 2). This situation has motivated further efforts in the development of valid tests tailored to the local context.

It is well established that psychological and social measures, therapeutic methods, and their tools are based on a body of knowledge and conceptual frameworks that originated in the West. These frameworks are closely linked to the experiences and specific cultural, economic, and social characteristics of Western societies. (Mahmoud, Z. M. 2017.P 360) However, these tests are currently applied in Algeria without due consideration of its unique contextual factors. This has led to persistent challenges at both individual and group levels. The application of these measures often results in cultural bias even within Western societies themselves; therefore, their use in

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Algeria, as an Arab-Islamic society, is even more problematic. Psychological tests developed in Western societies, when administered in different cultural and environmental contexts, tend to highlight racial, cultural, and religious distinctions rather than accurately reflecting the personal traits and characteristics of the individuals assessed.(Adda, D. 2016, p 20)

In Algeria, psychological tests and measures are frequently transferred through direct translation or Arabization, which necessitates adaptation to align with the specificities of Algerian society. Hence, there is an urgent need to evaluate the tests currently in use and to examine the criteria and degree of their suitability for the Algerian social and cultural environment (Bousalem, 2015).

A review of clinical practice in Algeria clearly reveals that specialists in language and speech disorders tend to rely heavily on standardized phonological tests, especially following the widespread employment of specialists across various sectors: healthcare, special education, general education, rehabilitation centers, and even security services. This widespread deployment necessitates that specialists utilize assessments supplemented by tests tailored to the clinical case, as they are compelled to conduct evaluations that require comparative analysis, which can only be achieved through specific evaluation instruments (Hafdhallah, 2015).

Careful observation and clinical interviews alone are insufficient for providing specialists with a comprehensive understanding of the linguistic, psychological, and cognitive functioning of the examinee, thus hindering the diagnostic process, which demands considerable time. Consequently, many specialists advocate the use of standardized tests to achieve a clear and precise diagnosis. For researchers to obtain valid and reliable results, their instruments must be appropriately suited to their objectives and meet scientifically recognized criteria for validity and reliability—that is, the tools employed must possess acceptable psychometric properties (Halim, Habbal, & Maamoun, 2017, p. 113). Moreover, applying these instruments in clinical practice requires meticulous attention and caution, particularly regarding the administration procedures and the interpretation of results, while respecting the cultural context in which the test was developed.

In light of the above, and within the framework of the core problem addressed in this study, as well as to enrich the Algerian clinical field with this category of assessment tools, the present article focuses on the attempt to adapt the NEEL language test for use within the Algerian community.

Study Problem:

The problem of this study can be formulated in the following main question:

Is it possible to adapt the NEEL language test, originally designed for children aged 4 to 6 years, for application within the Algerian context?

Sub-questions:

– Does the adapted NEEL language assessment, when applied to the Algerian environment, satisfy the test design criteria related to reliability?

– Does the adapted NEEL language assessment, when applied to the Algerian environment, meet the test design criteria concerning validity?

Study Hypothesis:

The NEEL language test, in its version intended for children aged 4 to 6 years, can be adapted for use within the Algerian context.

Study Objectives:

The current study aims to achieve the following objectives:

– To provide an objective analytical measurement tool through the adaptation of the NEEL test for the Algerian context, which is utilized to assess language and its levels in children aged 4 to 6 years, thereby offering a resource for specialists and researchers in the field.

– To attempt the adaptation of the section targeting the younger age group (4 to 6 years) within the language test, with the goal of evaluating the linguistic abilities of children.

– To employ this adapted test for the identification and diagnosis of children with language disorders, producing reliable results that facilitate early intervention and informed planning for appropriate care.

2. Operational Definitions of the Study:

2.1 Adaptation:

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The concept of test adaptation encompasses all procedures undertaken by the researcher, beginning with an assessment of whether the test can measure the same construct when transferred from one culture to another, and extending to efforts to obtain concepts, vocabulary, and expressions that are culturally, linguistically, and psychologically equivalent within the new cultural context of the test. Test adaptation involves more than merely translating the test contents from one language to another; it includes a series of carefully considered, phased modifications supported by scientific evidence to confirm that the test, in its current form, is valid for application and that its results are applicable to the new sample in accordance with their cultural characteristics (Bousalem, 2015, p. 189).

2.2 Language:

Language is defined as a system of responses that enables an individual to express thoughts and communicate with others. Thus, language fulfills the function of communication among individuals across all dimensions and aspects of interaction. (Adeeb, A., & Iman, T. 2015, p 38)Alternatively, language can be understood as a specific system of vocal symbols and expressive capabilities, referring to the means of communication through which humans symbolize their ideas and emotions. This includes written language, pictorial language, and spoken language, which utilizes a set of connected, distinct sounds (Tariq Abdul Raouf Amer, pp. 43–44).

2.3 Concept of Test Adaptation:

Nikto asserts that concepts developed within a particular culture are less effective when interacting with the cognition of individuals from other cultures, as these concepts cannot be directly imported. This is because they reflect the values and specificities of the culture in which they evolved and may contain values and opinions that distort perception and hinder deep understanding when applied in a different environment (Bousalem, 2015, p. 22).

This issue constitutes the core of the subject and reflects the practitioners' and researchers' lack of objective measurement tools that meet the criteria of validity, reliability, and sensitivity—particularly with regard to the linguistic dimension. Language is profoundly influenced by culture, and it is not feasible to operate effectively without tests derived from the cultural, linguistic, and social realities of the study population. Therefore, the time has come to initiate the construction of tests rooted in the local culture and language (Hussein Nawani, p. 183).

3. Fieldwork Component:

The primary focus in this section concerns the objectives of the field study, which include gaining a comprehensive understanding of the test and its components, exploring the site where the study will be conducted, outlining the procedures for administering the primary study and applying the assessment tool to obtain the research results, and verifying the psychometric properties of the instrument, alongside sample selection and defining practical steps.

3.1 Study Methodology:

This study employs a quasi-experimental design that examines the relationship between two variables as they exist naturally, without controlling for extraneous variables. A purposive sample from the target population was selected, with certain external variables remaining uncontrolled.

3.2 Study Sample and Its Characteristics:

The current study sample comprised 120 children (kindergarten and primary school students).

The characteristics of this sample are as follows:

− Gender: both male and female participants.
− Age: children aged between 4 and 6 years.
− Educational level: kindergarten, preparatory classes, and first-grade classes.
− Socio-cultural affiliation: this was addressed through random sampling of school-aged children within the Wilaya of Algiers, with cultural levels varying from one area to another.

3.3 Study Location:

The study was conducted in primary schools located in the eastern and central regions of the Algiers Province.

3.4 Study Instruments:

The N-EEL battery is a verbal and performance-based language assessment tool developed by Claude Cheverie-Muller and M. Plaza in 2001. It includes two distinct protocols: one designed for children aged 4 to 6 years, and another for children aged 6 to 8 years. This battery was published by the Applied Psychology Center in Paris (Les

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Editions du Centre de PsychologieAppliquée, ECPA) and facilitates a comprehensive evaluation of the components of language, including phonological level, lexical level, syntactic level, expressive language, and receptive language (Chevrie-Muller & Plaza, 2001, p. 12). The assessment reveals a child's linguistic abilities, proficiency in language use, and any deficits present in their language skills. The N-EEL test consists of 12 subtests, which are organized as follows:

–   Phonology and Articulation Test: (Naming) and (Repetition). This test includes a series of monosyllabic and polysyllabic words.

–   Phonology and Memory Test: Involves the repetition of infrequently used words.

–   Auditory-Verbal Memory Test: Number repetition.

–   Phonological Awareness Test:

- A-1: Harmony test

- A-2: Identification of the initial phoneme

- A-3: Syllable inversion

–   Morphosyntactic Comprehension Test: Comprises two series of contrasts in the syntactic structure of sentences.

–   Comprehension Test: (Topology 1 and Arithmetic 1).

–   Comprehension Test: (Arithmetic 2).

–   Expressive Vocabulary Test: (Naming) focused on naming concrete words, colors, shapes, and body parts.

–   Verbal Memory Test: Sentence repetition.

–   Expressive Verbal Test: Describing an ordered picture story (e.g., "Falling in the Mud").

–   Question Comprehension Test.

–   Lexical Comprehension Test: (Designation) identifying colors, shapes, and body parts.

3.5 Application Procedures:

The N-EEL battery, translated into colloquial Arabic, was first administered to an initial pilot sample for preliminary investigation, followed by a final sample of randomly selected male and female students from primary schools.

The pilot study served several purposes, including:

–   Testing the initial translated version of the battery to identify deficiencies and determine which elements were acceptable or unacceptable to children, with the aim of modifying or removing instructions accordingly.
–   Identify passages that are not comprehensible to Algerian children, as they may not align with their daily cultural experiences, (Malek, N. 1993, p 28)and collect all observations regarding items that elicited consensus on ambiguity or discrepancies in understanding.
–   Examine the field and potential challenges that may arise, estimate the actual time required to conduct the study, understand the conditions of implementation, and identify difficulties encountered during application while attempting to find appropriate solutions.
–   Develop an accurate understanding of the research context in Algeria and assess the feasibility of conducting this study, followed by preparation for the final study based on the findings derived from the preliminary exploratory study.
–   Pilot the test battery in its initial translated version to identify deficiencies, determine which elements are accepted or rejected by the children, and specify shortcomings in the application procedures of the study instrument. This aims to modify or eliminate instructions based on insights gained from the exploratory study— namely, identifying passages that Algerian children do not understand due to potential misalignment with their daily cultural life. Additionally, all observations regarding items that consistently caused ambiguity or varied interpretations were collected, along with information on the clarity of items before administering the battery to

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the adaptation sample. This process serves to establish indicators of validity and reliability for the measures within the Algerian context.

4. Statistical Analysis of the Study Results:

The Statistical Package for the Social Sciences (SPSS) software was employed for data entry and analysis, utilizing the statistical methods available within the program. The following stages will clarify this process:

4.1 Study Results:

To address the first research question: Does the N-EEL test, after adaptation to the Algerian context, meet the test design criteria related to reliability assessment?

4.1.1 Reliability:

This refers to the consistency and stability of results across different administrations of the test. The reliability of the test was assessed using Cronbach's alpha coefficient, which is one of the most widely recognized measures of internal consistency. The reliability of the test is directly related to the stability of its items. The results of internal consistency, as measured by Cronbach's alpha, were as follows:

Table 01: Reliability Results of the N-EEL Language Assessment Test Following Its Adaptation to the Algerian Context, as Measured by Cronbach's Alpha Coefficient

Test Domain			Cronbach's Alpha	Significance Level
1. Phonology and Articulation	Naming	1-A	0.579	0.01
		1-B	0.701	0.01
		1-C	0.561	0.01
	Repetition	1-A	0.734	0.01
		1-B	0.69	0.01
		1-C	0.688	0.01
2. Phonology and Memory		(A)	0.579	0.01
		(B)	0.558	0.01
3. Auditory Memory			0.482	0.01
4. Phonological Awareness		A-1	0.658	0.01
		A-2	0.713	0.01
		A-3	0.717	0.01
5. Morphosyntactic Comprehension		A	0.607	0.01
		B	0.722	0.01
6. Comprehension, Topology, and Arithmetic		Topology 1	0.641	0.01
		Topology 2–3	0.49	0.01
		Arithmetic 1	0.596	0.01
7. Comprehension		Arithmetic 2	0.596	0.01
8. Expression – Naming		Vocabulary 1 (Naming)	0.741	0.01
		Vocabulary 1 with Primary Aid	0.736	0.01
		Vocabulary 1 (Reduced)	0.718	0.01
		Vocabulary 1 Reduced with Primary Aid	0.669	0.01

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	Vocabulary 2 (Naming)	0.672	0.01
	Vocabulary 2 with Primary Aid	0.683	0.01
9. Verbal Memory	Sentence Repetition	0.676	0.01
10. Lexical Comprehension – Designation	Vocabulary 1	0.697	0.01
	Vocabulary 2	0.634	0.01

The table above demonstrates that the Cronbach's alpha coefficient ranged from 0.4820 in the auditory memory test—an indicator statistically significant at the 0.01 level—to 0.7410 in the expression-naming test (Vocabulary 1), also statistically significant at the 0.01 level. These coefficients are all relatively high, indicating that the test exhibits a high degree of reliability. This finding confirms that the adapted N-EEL language assessment test for the Algerian context meets the test design standards related to reliability assessment.

To address the second question—Does the adapted N-EEL language assessment test meet the validity criteria in terms of test design?

4.1.2 Validity:

The validity study employed both expert judgment validity and internal consistency validity methods.

−   Expert Judgment Validity: This form of validity relies on the subjective evaluation of a panel of specialists in the relevant field. We applied this method to review the content of the instrument and collect expert opinions prior to its administration. The preliminary version of the test was presented to a group of eight experts and researchers specializing in orthophony, clinical psychology, statistics, and the French language. Each expert was asked to provide feedback on the test, evaluate the items with respect to the intended measurement objectives, and assess the coherence of items within their respective sections. The experts reached a consensus on the test and the procedures for its administration, which serves as evidence supporting its content validity.

−   Internal Consistency Validity: This approach involved calculating correlation coefficients among the different dimensions of the test to determine the degree of consistency between them. Specifically, the correlation between each subtest within the battery and the overall battery was computed to evaluate the test's validity.

The following table presents the internal consistency coefficients for the various subtests:

Internal consistency was examined by correlating the scores of each subtest with the total score, as presented in the table above. The correlation coefficients among all subtests of the battery were found to be statistically significant at the 0.01 level, indicating the test's validity and its suitability for use.

Based on the results obtained from the validity study employing the aforementioned methods, it can be concluded that the adapted N-EEL language assessment test meets the test design criteria related to validity.

5. Discussion of Results:

Considering the results obtained regarding the internal consistency validity of the test items, as measured by Cronbach's alpha coefficient, we have confirmed both the validity and reliability of the battery of tests. Consequently, the test is deemed suitable for application. The study thus concludes that linguistic adaptation of the instrument is feasible, aiming to provide a tool in the Algerian dialect that enables objective evaluation of examinees in the field setting.

6. Conclusion:

Speech pathology specialists rely on various assessment tools to evaluate their research and clinical interventions. However, these psychological and social measures, therapeutic methods, and their instruments are often grounded in knowledge and conceptual frameworks developed in Western contexts. These frameworks are closely linked to the cultural, environmental, economic, and social specificities of Western societies, yet they are currently applied in Arab communities without due consideration of their particularities. This practice results in cultural bias even within Western societies, which becomes more pronounced when such tools are used in Arab and Islamic societies. Psychological and other tests developed in Western contexts, when administered in different cultural and environmental settings, tend to highlight racial and cultural distinctions rather than accurately reflecting the traits and characteristics they were designed to measure (Bousalem, 2015, p. 22). This is because test items are often related to the individual's social and cultural experiences. For instance, intelligence tests ask children about concepts relevant to their family, school, and social environment,(Saad, A. 2008, p 37)

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while language tests assess the language acquired within these contexts. Consequently, there is a critical need for each society to develop its own tools that measure cognitive, psychological, and linguistic characteristics. Professionals using imported tests must recognize that most of these tools are deeply embedded in cultural factors. Therefore, it is imperative to invest efforts in adapting these tools to ensure their applicability within the local environment without succumbing to cultural bias (Halim, Habbal, & Maamoun, 2017, p. 10).

In this regard, RachidAitSahlia adds that the use of Western tests in Algeria is particularly challenging due to their close ties to the social, cultural, and linguistic factors influencing the child. Moreover, any test requires periodic recalibration, as it ages and becomes less aligned with societal changes. In other words, there is no definitive test; it is always contingent upon a specific population at a particular moment in its history (Sahlia, 1981, p. 03).

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Table 02: Correlation Coefficients Between the Subtests of the N-EEL Test Adapted to the Algerian Context

Phonological Awareness = P.A_A1
Morphosyntactic Comprehension = M.C
Topology and Arithmetic = T.A
Phonology_Memory = P.M
Expression_Naming = E.N
LexicalComprehension Vocabulary = L.C.V

Naming_A1	Naming_B1	Naming_C1	Repetition_A1	Repetition_B1	Repetition_C1	P.M_A	P.M_B	Auditory Memory	P.A_A1	P.A_B1	P.A_C1	M.C_A	M.C_B	T.A_T1	T.A_T2_3	T.A	Comprehension_Arithmetic_2	E.N_1	E.N_2	E.N_3	E.N_4	E.N_5	E.N_6	Verbal Memory	L.C.V 1	L.C.V 2
1	,524**	,551**	,792**	,505**	,387**	,468**	,428**	,415**	,564**	,620**	,322**	,230*	,181*	,287**	,377**	,094	,279**	,317**	,359**	,479**	,459**	,528**	,445**	,332**	,510**	,476*
	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,004	,012	,048	,002	,000	,307	,002	,000	,000	,000	,000	,000	,000	,000	,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,524**	1	,628**	,430**	,647**	,429**	,464**	,184*	,432**	,487**	,437*	,589*	,391*	,311*	,294*	,466**	,220*	,171	,460**	,491**	,500**	,504**	,477**	,248**	,381**	,529**	,415*
,000		,000	,000	,000	,000	,000	,044	,000	,000	,000	,000	,000	,001	,001	,000	,016	,062	,000	,000	,000	,000	,000	,006	,000	,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,551**	,628**	1	,396**	,396**	,738**	,238**	,123	,298**	,454*	,448*	,558*	,262*	,165	,251*	,280**	,134	,157	,527**	,531**	,495**	,440**	,541**	,408**	,361**	,523**	,448*
,000	,000		,000	,000	,000	,009	,180	,001	,000	,000	,000	,004	,072	,006	,002	,144	,087	,000	,000	,000	,000	,000	,000	,000	,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,792**	,430**	,396**	1	,538**	,342**	,347**	,403**	,257**	,418*	,362*	,089	,083	,093	,106	,149	,027	-,019	,083	,132	,292**	,303**	,409**	,357**	,080	,337**	,313*
,000	,000	,000		,000	,000	,000	,000	,005	,000	,001	,435	,367	,314	,250	,105	,773	,840	,365	,150	,001	,001	,000	,000	,386	,000	,001
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,505**	,647**	,396**	,538**	1	,471**	,358**	,212*	,216*	,526*	,388*	,234*	,243*	,160	,216*	,303**	,212*	,068	,195*	,257**	,440**	,447**	,339**	,319**	,308**	,445**	,279*
,000	,000	,000	,000		,000	,000	,020	,018	,000	,000	,036	,007	,081	,018	,001	,020	,463	,033	,005	,000	,000	,000	,000	,001	,000	,002
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,387**	,429**	,738**	,342**	,471**	1	,183*	,144	,253**	,423*	,295*	,366*	,143	,128	,232*	,300**	,198*	-,057	,324**	,336**	,421**	,365**	,366**	,377**	,304**	,447**	,392*
,000	,000	,000	,000	,000		,046	,117	,005	,000	,008	,001	,120	,164	,011	,001	,030	,535	,000	,000	,000	,000	,000	,000	,001	,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
,468**	,464**	,238**	,347**	,358**	,183*	1	,677**	,632**	,270*	,257*	,241*	,311**	,219*	,332**	,508**	,116	,091	,147	,165	,305**	,407**	,218*	,188*	,515**	,212*	,203*
,000	,000	,009	,000	,000	,046		,000	,000	,016	,021	,031	,001	,016	,000	,000	,208	,324	,109	,072	,001	,000	,017	,039	,000	,020	,026
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,428**	,184*	,123	,403**	,212*	,144	,677**	1	,583**	,168	,033	,089	,147	,143	,165	,329**	-,176	-,136	-,043	,006	,149	,249**	,118	,098	,398**	,083	,174
,000	,044	,180	,000	,020	,117	,000		,000	,135	,773	,430	,109	,119	,071	,000	,055	,138	,644	,948	,104	,006	,201	,289	,000	,365	,057
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,415**	,432**	,298**	,257**	,216*	,253**	,632**	,583**	1	,422**	,352**	,539**	,427**	,486**	,405**	,386**	,233*	,128	,306**	,320**	,351**	,363**	,224*	,179	,497**	,221*	,250*
,000	,000	,001	,005	,018	,005	,000	,000		,000	,001	,000	,000	,000	,000	,000	,010	,163	,001	,000	,000	,000	,014	,051	,000	,015	,006
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,564**	,487**	,454**	,418**	,526**	,423**	,270*	,168	,422**	1	,617**	,438**	,353**	,276*	,419**	,223*	,327**	.c	,363**	,400**	,477**	,447**	,474**	,247*	,474**	,503**	,456**
,000	,000	,000	,000	,000	,000	,016	,135	,000		,000	,000	,001	,013	,000	,047	,003	,000	,001	,000	,000	,000	,000	,027	,000	,000	,000
80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
,620**	,437**	,448**	,362**	,388**	,295**	,257*	,033	,352**	,617**	1	,586**	,358**	,329**	,314**	,273*	,543**	.c	,630**	,625**	,549**	,513**	,618**	,517**	,366**	,531**	,363**
,000	,000	,000	,001	,000	,008	,021	,773	,001	,000		,000	,001	,003	,005	,014	,000	,000	,000	,000	,000	,000	,000	,000	,001	,000	,001
80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
,322**	,589**	,558**	,089	,234*	,366**	,241*	,089	,539**	,438**	,586**	1	,298*	,468**	,401**	,313**	,432**	.c	,729**	,763**	,622**	,576**	,587**	,358**	,396**	,553**	,247*
,004	,000	,000	,435	,036	,001	,031	,430	,000	,000	,000		,007	,000	,000	,005	,000	,000	,000	,000	,000	,000	,000	,001	,000	,000	,027
80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
,230*	,391**	,262**	,083	,243**	,143	,311**	,147	,427**	,353**	,358**	,298*	1	,505**	,503**	,387**	,362**	,157	,241**	,204*	,252**	,217*	,211*	,144	,404**	,257**	,242*
,012	,000	,004	,367	,007	,120	,001	,109	,000	,001	,001	,007		,000	,000	,000	,000	,086	,008	,026	,006	,017	,021	,118	,000	,005	,008
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,181*	,311**	,165	,093	,160	,128	,219*	,143	,486**	,276*	,329**	,468**	,505**	1	,670**	,345**	,354**	,209*	,264**	,262**	,352**	,312**	,135	,139	,404**	,193*	,134
,048	,001	,072	,314	,081	,164	,016	,119	,000	,013	,003	,000	,000		,000	,000	,000	,022	,004	,004	,000	,001	,140	,130	,000	,034	,145
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,287**	,294**	,251**	,106	,216*	,232*	,332**	,165	,405**	,419**	,314**	,401**	,503**	,670**	1	,490**	,349**	,377**	,160	,119	,272**	,237**	,139	,172	,572**	,202*	,162

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,002	,001	,006	,250	,018	,011	,000	,071	,000	,000	,005	,000	,000	,000		,000	,000	,000	,081	,195	,003	,009	,130	,060	,000	,027	,078
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,377**	,466**	,280**	,149	,303**	,300**	,508**	,329**	,386**	,223*	,273*	,313**	,387**	,345**	,490**	1	,315**	,061	,227*	,286**	,381**	,415**	,264**	,240**	,597**	,420**	,441*
,000	,000	,002	,105	,001	,001	,000	,000	,000	,047	,014	,005	,000	,000	,000		,000	,509	,013	,002	,000	,000	,004	,008	,000	,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,094	,220*	,134	,027	,212*	,198*	,116	-,176	,233*	,327**	,543**	,432**	,362**	,354**	,349**	,315**	1	,118	,266**	,244**	,305**	,212*	,248**	,238**	,216*	,275**	,237*
,307	,016	,144	,773	,020	,030	,208	,055	,010	,003	,000	,000	,000	,000	,000	,000		,199	,003	,007	,001	,020	,006	,009	,018	,002	,009
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,279**	,171	,157	-,019	,068	-,057	,091	-,136	,128	.c	.c	.c	,157	,209*	,377**	,061	,118	1	,282**	,234*	,252**	,059	,206*	,173	,242**	,264**	,117
,002	,062	,087	,840	,463	,535	,324	,138	,163	,000	,000	,000	,086	,022	,000	,509	,199		,002	,010	,006	,522	,024	,059	,008	,004	,205
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,317**	,460**	,527**	,083	,195*	,324**	,147	-,043	,306**	,363**	,630**	,729**	,241*	,264*	,160	,227*	,266**	,282**	1	,937**	,809**	,686**	,702**	,588**	,321**	,506**	,426*
,000	,000	,000	,365	,033	,000	,109	,644	,001	,001	,000	,000	,008	,004	,081	,013	,003	,002		,000	,000	,000	,000	,000	,000	,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,359**	,491**	,531**	,132	,257**	,336**	,165	,006	,320**	,400**	,625**	,763**	,204*	,262*	,119	,286**	,244**	,234*	,937**	1	,791**	,749**	,658**	,564**	,327**	,560**	,372*
,000	,000	,000	,150	,005	,000	,072	,948	,000	,000	,000	,000	,026	,004	,195	,002	,007	,010	,000		,000	,000	,000	,000	,000	,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,479**	,500**	,495**	,292**	,440**	,421**	,305**	,149	,351**	,477**	,549**	,622**	,252*	,352**	,272*	,381**	,305**	,252**	,809**	,791**	1	,873**	,721**	,635**	,417**	,647**	,478*
,000	,000	,000	,001	,000	,000	,001	,104	,000	,000	,000	,000	,006	,000	,003	,000	,001	,006	,000	,000		,000	,000	,000	,000	,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,459**	,504**	,440**	,303**	,447**	,365**	,407**	,249*	,363**	,447**	,513**	,576**	,217*	,312**	,237*	,415**	,212*	,059	,686**	,749**	,873**	1	,609**	,553**	,397**	,622**	,363*
,000	,000	,000	,001	,000	,000	,000	,006	,000	,000	,000	,000	,017	,001	,009	,000	,020	,522	,000	,000	,000		,000	,000	,000	,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,528**	,477**	,541**	,409**	,339**	,366**	,218*	,118	,224*	,474**	,618**	,587**	,211*	,135	,139	,264**	,248**	,206*	,702**	,658**	,721**	,609**	1	,841**	,254**	,589**	,713*
,000	,000	,000	,000	,000	,000	,017	,201	,014	,000	,000	,000	,021	,140	,130	,004	,006	,024	,000	,000	,000	,000		,000	,005	,000	,000

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120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,445**	,248**	,408**	,357**	,319**	,377**	,188*	,098	,179	,247*	,517**	,358*	,144	,139	,172	,240**	,238**	,173	,588**	,564**	,635**	,553**	,841**	1	,254**	,458**	,580*
,000	,006	,000	,000	,000	,000	,039	,289	,051	,027	,000	,001	,118	,130	,060	,008	,009	,059	,000	,000	,000	,000	,000		,005	,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,332**	,381**	,361**	,080	,308**	,304**	,515**	,398**	,497**	,474**	,366**	,396**	,404**	,404**	,572**	,597**	,216*	,242**	,321**	,327**	,417**	,397**	,254**	,254**	1	,397**	,401*
,000	,000	,000	,386	,001	,001	,000	,000	,000	,000	,001	,000	,000	,000	,000	,000	,018	,008	,000	,000	,000	,000	,005	,005		,000	,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,510**	,529**	,523**	,337**	,445**	,447**	,212*	,083	,221*	,503**	,531**	,553**	,257**	,193*	,202*	,420**	,275**	,264**	,506**	,560**	,647**	,622**	,589**	,458**	,397**	1	,564*
,000	,000	,000	,000	,000	,000	,020	,365	,015	,000	,000	,000	,005	,034	,027	,000	,002	,004	,000	,000	,000	,000	,000	,000	,000		,000
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
,476**	,415**	,448**	,313**	,279**	,392**	,203*	,174	,250**	,456**	,363**	,247*	,242**	,134	,162	,441**	,237**	,117	,426**	,372**	,478**	,363**	,713**	,580**	,401**	,564**	1
,000	,000	,000	,001	,002	,000	,026	,057	,006	,000	,001	,027	,008	,145	,078	,000	,009	,205	,000	,000	,000	,000	,000	,000	,000	,000	
120	120	120	120	120	120	120	120	120	80	80	80	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120

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7. Appendices. Figure 01: Represents the components of the battery in the original formula

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