Cognitive Control Performance as Measured by Clustering and Switching in Nepali – English Bilingual Verbal Fluency Task

Lekhnath Sharma Pathak[1], Nishan Pathak[2], Aarya Pathak[3]

[1] Cognitive Science and Psycholinguistics Lab, Central Department of Linguistics, Tribhuvan University, Kirtipur, Kathmandu, Nepal

[2] Department of Computer Engineering, Kantipur Engineering College, Tribhuvan University, Dhapakhel, Kathmandu

[3] Department of Computer Science and Engineering, Kathmandu University, Dhulikhel

ARTICLE INFO

ABSTRACT

Verbal fluency task is a simple yet powerful neuropsychological tool for measuring linguistic and cognitive processing. In this research article we report the clustering and switching, as identified by Troyer and colleagues (1997), as cognitive control measured through semantic and phonetic verbal fluency task. We tested 25 Nepali (L1) - English (L2) bilingual adults with mean age of 22 years on f, a, s for English phonemic fluency, क, प, म for Nepali phonetic fluency and animals, cloths, vegetables, fruits and flowers for semantic fluency in both Nepali and English. The participants performed better in L2 phonetic fluency compared to L1 phonetic fluency, whereas, there was mixed results in semantic output in both the languages. They exhibited more clusters in phonetic fluency compared to semantic fluency in both L1 and L2 which indicates participants needed to disengage from the previous strategy or subcategory and move on to the next strategy or subcategory, thus, reflecting more cognitive demand imposed by the phonetic fluency compared to semantic fluency. This is the first such study with Nepali – English bilinguals. This study may further be extended to include more diversified population in terms of age, language family, typicality and ethnicity as independent variables.

Keywords: Nepali-English bilinguals, semantic and phonetic verbal fluency, clustering and switching, cognitive control, bilingualism

Introduction

Constitutional provisions related to language education and research in Nepal are given in Part 3 of the Constitution of Nepal (2015) under Fundamental Rights and Duties ensures the Rights relating to education under Article 31. Section 5 of Article 31 states "Every Nepalese community residing in Nepal shall have the right to get education in its mother tongue and, for that purpose, to open and operate schools and educational institutes, in accordance with law". In order to achieve the language related responsibilities of the State, the Constitution envisages Language Commission in Article 287. Section 6 of Article 287 deals with "The functions, duties and powers of the Language Commission". Sub-section (c) of Section 6 of Article 287 states its function "to measure the levels of development of mother tongues and make

suggestions to the Government of Nepal, on the potentiality of their use in education". Sub-section (d) entrusts the Language Commission "to study, research and monitor languages". This research fulfils the constitutional responsibility of the Language Commission by extending the current state of the knowledge in the use of language as medium of instruction.

Verbal Fluency Task as a Psycholinguistic Tool

As a neuropsychological test used both in clinical and experimental situations (Troyer et al, 1997), verbal fluency task measures the mental lexical representation and organization of words in phonetic or letter and semantic or categorical basis (Troyer et al, 1997; Friesen et al, 2015; Luo et al, 2010). Neuronally, phonetic fluency has been ascribed to frontal lobe (Coslette et al, 1991; Perret, 1974) and semantic fluency is ascribed to temporal lobe (Newcombe, 1969). Verbal fluency task is a rapid search and retrieval (Patra et al, 2020; Pathak et al, 2021) of mental lexicon. In this task, participants are given letter or category items and they have to make as many words as they can in 60 seconds from the given item. For example, in phonetic fluency task the participants are given three letters f, a, and s to create as many words as they can. Likewise in semantic fluency task in which they are given a category like animal, vegetable, cloth and they have to make as many words as they can within the given time. Thus, it makes an excellent tool to study language production in psycholinguistic researches (Whiteside et al, 2016). Researchers have used this task in bilingual context in various language pairs like Mandarin – English (Eng et al, 2018), Spanish – English (Rosselli et al, 2000; Gollan et al, 2002), Bengali – English (Patra et al, 2020) and across different age groups like primary school children (Kormi-Nouri et al, 2012), among teenagers (Pathak et al, 2021; Pathak & Rijal, 2022), college students (Portocarrero et al, 2007), healthy older bilinguals (Rosselli et al, 2000) and across the lifespan (Friesen et al, 2015).We have used this task in Nepali – English pair among healthy adults college students in this study.

Cognitive Mechanism in Verbal Fluency Task

Troyer and colleagues (1997) have identified two cognitive mechanisms involved in verbal fluency tasks: clustering and switching. They have identified four phonemic characteristics of clustering on phonemic fluency trials: first letters (words beginning with same first two letters, such as arm and art); rhymes (words that rhyme such as sand and stand); first and last sounds (words differing only by a vowel sound, regardless of the actual spelling such as sat, seat, sight and sought) and homonyms (words with two or more different spellings, such as some and sum). They identify clustering in semantic fluency trials consisting of successively generated words belonging to the same subcategories which are, for example (in case of animal categories), organized by living environment, human use and zoological categories. The authors suggest "switching may be related primarily to participant's ability to disengage from a previous strategy or subcategory and would thus be impaired by preservative behavior". Herein lies the explanation to executive control in verbal fluency task.

Performance in semantic fluency is relatively easier as the words to be generated resemble the pattern to everyday language use as the participants have to recall items from everyday life like cloths, animals, vegetables whereas in letter fluency is more challenges as the words have to be generated from a given letter which is not like the everyday normal pattern and requires participants to suppress the activation of words from semantic category (Luo et al, 2010; Friesen et al, 2015)

Methodology

This study adopted the bilingual oral elicitation methodology. This methodology allowed us to elicit the oral data on bilingual phonemic and semantic lexical organization. The lexical output was analyzed following the clustering and switching criteria as identified by Troyer and colleagues (1997). This study was conducted on the Nepali-English bilingual college students in the campus. The analysis has been done as within-

subject performance without ANOVA and t-test, or correlation and regression analysis.

Method

Participants

A total of 25 adult participants who were Nepali – English bilinguals were recruited for this study. The participants were college students, with mean age of 22 years.

Stimuli and procedure

Participants were given 60 seconds to create words from the given semantic category (clothes, animals, fruits, vegetables, flowers) or letter/phonetic category. Verbal fluency Task is also used to measure verbal cognitive control as words in semantic category are easier to produce than the words in phonetic category. This study used the following verbal fluency task stimuli:

Phonetic Fluency L1:क, प, म

Phonetic Fluency L2: F, A, S

L1 Semantic Fluency: जनावर, लुगा, फल, तरकारी, फूल

L2 Semantic Fluency: Animals, cloths, Fruits, Vegetables, Flowers

Data Collection

Data were recorded from each participant in Audacity software for verification and was transcribed after the completion of data collection. In the following tables, we provide the exemplars of each verbal fluency task for the first five participants as a way of illustrating the vft production output.

Table 1

L1 Phonetic Fluency

Std I.D	क	प	म
1.	कमल, कैलाश, कपुर, कन्यादान, कलकल, किसान, किसमिस, कैशौदी, काम, कुचो	पवन, पुकार, पञ्चकन्या, पसमिना, पिरो , पिर्का, पिनास, पिसाब, पसिना, पेवा, पापा, पापी, पागल, पुराण, पागल, पौवा, पाटी	मैलो, माला, मिठो, मुहार, मलामी, महिला, माखा, मेवा,मिहिनेत, मात, मार्ग, मायालु, माया, मसिनो
2.	कुखुरा, कमल, कैलाश, कोपिला, किरण,कपुर, किसान, किसन, किनार, कपाल, केश, काईयो, कोरयो, किरा, कुइरो, केरा, कसरी, कोसै, कयौ, कति, काहां, कसरी, कहिले, किन, कोटा, कोठा	परेवा, पुच्छर, पानी, पदेरा, पोखरी, पिनास, पितल, पाइला, पछि, पहिरो, पित्त, पनेरु, पोखरी, पोहोर, पराहार, पङ्खा, पखेटा, पश्चिम	मैले, माछा, मलाई, म, मिना, मोती, मास्टर, मिस्टर, महिलो, मकालु, माखा, मायालु, माया, माछापुच्छे, मुसा,मच्छड, मधुरो, मखखन, मानिस, मानिस, मान्छे
3.	कछुवा, कलम, कलश, को, किरण, कर, किताब, किसान, किन, कबिता, कवि, कसरी, क्रियापद, कुलो, कुलो, कर्म, कुचो, कुवा	परेवा, पानी, पोखरी, पनि, पास, परेवा, पुजा, पुराण, पुरेत, पङ्खा, पङ्, पलेटी, पश्चिम, पश्चिम, पौडिनु	महल, माइलो, मितीनी, मित मुहान, मुल, मुस्कान, मोहनी, मोहित, मज्जा, मोजा, माछा, मिहिनेत, मिरिचे, मात्तिनु, मस्किनु, मिलनु
4.	कछुवा, कलम, कलम, कोपिला, करेसा, कहल्ला, कुनिउ, कोदो, कोदालो, कछुवा, करेसाबारी, कहां, कन्दरा, कहिले, काहि, किन, कस्को, कसरि, कोही	परेवा, पन्छी, पराई, परिवार, पलसर, परिकार, पछि, पछि, पन्छाई, पराई, प्रसाद, पन्देरु, पानी, पुरस्कार, प्रतिष्ठा, प्रग्या, पुजा, पुरस्कृत पूर्ण, पुनित, पुस्कर, पुरोसतम	मौरी, मह, मखखन, मेवा, मेग, मेगलय, मेथी, मन, मस्तिष्क, मनमुटाव, मोटो, माथितिर, मालिस, मानार्थ, मादिवेशन, मनोनयन, माननिय, मनृतिरि,
5	कलम, कपी, कमला, क, का, कि, की, कराई, कासि,	परेवा, प्रणाम, पर्मेश्वर, प्रभू, पारिजात, पोखेल, पौडेल, परिणाम, पोषण, प्रमोद, पर्खाल, प्रसाद	मलाई, मेरो, मकै, मासु, मकर, मिठो

Table 2

L2 Phonetic fluency

Stud I.D	F	A	S
1.	Fruit, flower, face, far, forth, feel, fuel, farm, further, future, fame, feel, fat, further, following	Analogy, anatomy, analogous, adventure, Arial, anaconda, atrophic, axe, areal, arcade, auto, a look, alike, action	Sheep, such, sex, soon, sunset, seem, sick, such, so, salmon, see, sand, sore, stick
2.	Friend, family, frost, find, forgive, female, fire, fish, find, finger, find, focus, faint, friends, furniture, febikel, faster, fabric, fib nicks	Apple, Anker, axe, ant, animal, afoul, awesome, amazing, aunt, another, annoying, an, authorized, ac, audible	Squirrel, stage, sky, setting, start, selection, strike, stable, stereo, slow, space, second, speakers, silent, series, sequence, sleep, slippers, shoes, shocks, suit, size, shape, structure
3.	Frog, fish, fun, float, feel, fool, fool, float, find, finger, falls, fun, film, from, for, feasible, fit, found, finish	Arrange, ant, and, animal, anguish, angry, anticipate, artificial, article, around, Anker, abolishes, abandon, assume, always, allow, ambulance, achieve, astonish, around, airplane, appear, amuse, antominuse	Survive, succeed, success, summarize, show, such, symbol, sympathized, system, systematized, slogan, slow, self, surrounded, surrender, sea, seen, swim, signal, such, symbol, settle, sample
4.	Find, flower, floors, flatter, flunk, fan, flank, fettle, fat, fuck, feather, fears, fever, fear, feelings, forecast, fake	Ant, antilock, ambitious, attire, achievement, allocation, approve, ambulance, awards, assists, allocate, antilock, ask, arm, alien, allies, axis, axe, apostle, akin, alloy, ant light	Serve, survive, success, salary, submission, stipend, secular, sadistic, sit, sex, sophisticated, salad, sublime, successive, slumber, sky, skating
5	Food, fruit, fund, funny, founder, flower, fruit, frozen, fluid, foolish, family, familiar, fantastic, fun, fund	Admin, admire, adjustable, accomplish, and, affordable, admire, antagonist, adamant, annoy, artist, ant	Shoe, shock, somehow, specular, spontaneous, similar, sky, sea, ship, spring, shirt, sky

Table 3

L1 Semantic Fluency

Std I.D	जनावर	फलफुल	कपडा	तरकारी	फुल
1.	बिरालो, कुकुर, गाई, भैँसी, फटाङ्ग्रो, सर्प, कालिज, छेपारो, भ्यागुता, हरिण, मिर्ग, हात्ती, बाघ, भालु, चितुवा, कङ्गारु, पान्डा, खच्चढ	आँप, स्याउ, सुनताला, केरा, अनार, लिच्ची, अम्बा, किमु, बदाम, अङ्गुर, अनार, केरा	सट, पेन्ट, कमिज, कुर्थासुरवाल, ढाका, गुन्योचोलो, आसकोट, मोजा, जुत्ता, चप्पल, गन्जी, कट्टु, पेटिकोट, दौरासुरवाल, जाकेट, मफलर, कोट	आलु, काउली, भेन्टा, घिरौला, सिमी, सोइबिन, फर्सी, लौका, गोबी, करेला, चिचिन्नो, बरेला, लसुन, प्याज, सिन्की, गोलभेडा, खुर्सानी, मुला, गाजर	गुलाब, लालिगुराँस, मखमली, सयपत्री, पलास, पारिजात, कमल, गोदावरी

Std I.D	जनावर	फलफुल	कपडा	तरकारी	फुल
2	कुखुरा,चमेरा, हात्ती, गाई, गोरु, कुखुरा, बाघ, भालु, जरायो, खरायो, गैँडा, हरिण, स्याल, बच्छो, चिल, मयुर, बाँदर, गदा, घोडा, बिरालो, बोका, मुसा	आँप, स्याउ, सुन्ताला, केरा, अनार, अम्बा, बदाम, अङ्गुर, आरु, कटर, भुइकटर, किम्बा, औशेलु, स्ट्राबेरी, पिडालु,	सट, पेन्ट, टिःसट, रुमाल,मोजा, गन्जी, पन्जा, जाकेट, स्टकोट, फराक, टाउजर, पन्जा, सुट, सारी, सुइटर	आलु, काउली, भेन्टा, भेन्डी, चिप्फलेभेन्डी, सोइबिन, लौका, गोबी, प्याज, परबल, राजमा, लसुन	गुलाब, लालिगुराँस, पारिजात, सयपत्री, चमेली, सिरिस, सुर्यमुखी
3	गाई, बाखा, भैँसी, बाघ, घोडा, जिराफ, जेब्रा, बिरालो, कुकुर, भैँसी, हात्ती, गैँडा, चितुवा, हरिण, मिर्ग, गदा, खच्चढ, चौरी, गाई, भैँडा , मुसा, होयल, सार्क	आँप, स्याउ, सुनतला, नासपती, जुनार, उखु, अङ्गुर, कटर, भुइकटर,	पेन्ट, सट, टाई, मोजा, कोट, बेल्ट, टिःसट, बेलेजर, जाकेट, कट्टु गन्जी, रुमाल, पेन्ट, धोती, कङ्की, कछाड	आलु, भेन्डी, घिरौला, सिमी, टमटर, ब्रोकउली, भिम्नी, धनिया, फसी, लौका, बन्दागोबी, कुबिन्डो, सिमी, खुर्सानी, लौका, गोबी, प्याज, परबल, लसुन	गुलाब, लालिगुराँस, पारिजात, सयपत्री, चमेली, सुर्यमुखी , मखमली, कमल, जाईजुई
4	गाई, गदा, गैँडा, हात्ती, कछुवा, बाँदर, मुसा, जल गैँडा, भैँसी, मिल गाई, हरिण, सुतुर मिर्ग, किसनसार, अर्ना भैँसी, बाघ, सिंह, कुकुर, खरायो, बनमान्छे, गोही	स्याउ, अनार, सुनताला, केरा, अङ्गुर, रुख कटर, भुइकटर, चरिफा, मौसम, सुनताला, ओखर, खरबुजा, अम्बा, चेरी, कन्दमुल, सखरखन्ड, आँप, लिच्ची, आलुबखडा, आरु, काजु, छोक्डा,	जुत्ता, मोजा, कट्टु, पटुका, गन्जी, कछाड, धोती, कुर्था, टोपी, गलबन्दी, मफलर, ओडने मजेत्रो, राडी पाखी, सट, पेन्ट	आलु, बन्दा, गोपी, काउली, प्याज, फसी, लौका, करेला, भेन्टा, सोइबिन, भट्टमास, खुर्सानी, भिडे खुर्सानी, साग, तरुल, घिरौला, चिचिन्नो, कटर, करकलो	गुलाब, पारिजात, सयपत्री, मखमली, कमल, सिरिस
5	हात्ती, घोडा, गैँडा, बिरालो, कुकुर, गदा, खच्चढ, बाँदर, सर्प, भ्यागुता, खच्चढ, गदा, गाई, गरु, भैँसी, बिरालो	स्याउ, सुनताला, अङ्गुर, अनार, मेवा, भुइकटर, केरा, बदाम, अम्बा, कुसुम	सट, पेन्ट, कट्टु, कोट, दौरासुरवाल, सारी, बलाउज, आसकोट, मोजा	गोबि, भेन्टा, काउली, बन्दा, भेन्डी, मुला, आलु, पेडालु, तरुल	गुलाब, लालिगुराँस, डाली, कमल

Table 4

L2 Semantic fluency

Stud I.D	Animals	Fruits	Clothes	Vegetables	Flowers
1.	Cat, dog, lion, tiger, giraffe, rat, donkey, monkey, elephant, zebra, squirrel, mongos, ant, octopus, earthworm, starfish, jellyfish, cow, leopard, frog, snake, camel, horse	Orange, guava, apple, bananas, graphs, pomegranate, banana, pitch, papaya, mango, cucumber	t-shirt, shirt, pant, half-pant, shoes, shocks, muffler, coat, guan, one-piece, bra, lingerer, underwear, hill, boot, cap, sherwani, suit	Tomato, onion, brinjal, ladyfinger, potato, cheese, soybean, pork	Rose, Lilly, marigold, tulip, rhododendron, mimosa, blue mimosa, lotus
2.	Cat, dog, rabbit, cow, buffalo, ox, rat, mouse, dog, peacock, wolf, tiger, leopard, lion, monkey, donkey, horse, zebra, rhinoceros, hippopotamus, elephant, deer, squirrel, python, wolf, fox, snake, lizard, spider	Banana, apple, graphs, mango, pomegranate, guava, strawberry, litchi, ground nuts, carrot, orange, raspberry, blueberry	Pant, shirt, t-shirt, sleepless, skirt, trouser, shocks, hanky, gloves, handkerchief, coat, pajama, shirts, sari, suits, raincoat, jacket, sweater, outer	Spinach, potato, tomato, garlic, cabbage, cauliflower, radish, mustard leafs, brinjal, ladyfinger, , onion	Jasmine, rose, sunflower, rhododendron, Lilly, lotus
3.	Elephant, cow, dog, tiger, lion, giraffe, leopard, buffalo, ox, zebra, crocodile, horse, bear, goat	Apple, orange, banana, graphs, pomegranate, jackfruit, pineapple, boyar, cherry, star fruit	shirt, t-shirt, jacket, pants, shocks, shoes, underwear, jacket, hoodies, tie, belt, coat, jeans, rest pant, lizard, blazer	Cauliflower, cabbage, potato, tomato, brinjal, chilly, pumpkin, cauliflower, broccoli, ladyfinger, pears	Marigold, rhododendron, rose, lotus, Lilly
4.	Cat, mouse, donkey, horse, maul, lion, tiger, dog, leopard, elephant, sheep, buffalo, cow, giraffe, leopard, tiger, dog, leopard, tiger, lion rabbit, cow, deer, blue huff, atilt, zebra, ox, camel	Apple, orange, lemon, graphs, pineapple, banana, litchi, mango, cucumber, carrot, guava, sugarcane, pineapple, coconut, blue berry, strawberries, papaya	Shocks, shoes, pant, underwear, belt, t-shirt, vest, cap, midcap, gloves, armband, sari, petticoat, coat, t-shirt, silver, kurtha, dhoti, hat, Sal, sweater, jacket, burkha, nakab	Cabbage, cauliflower, bittergurd, potato, tomato, garlic, green leaf, brinjal, spinach, pumpkin, peach, chilly, cucumber	Rose, Lilly, lotus, rhododendron, jasmine

Clustering

Phonemic characteristics of clustering on phonemic fluency trials in L1

first letters (words beginning with same first two letters, such as snd snz snsn) (कमल, कपुर, पवन, पञ्चकन्या माला मलामी

rhymes (words that rhyme such as परेवा पँधेरा) – काईयो कुईरो कोटा कोठा

first and last sounds (words differing only by a vowel sound, regardless of the actual spelling such as मेथी माथि) मजा मोज पिनास पसिना किरा केरा

homonyms (words with two or more different spellings, such as some and sum) in Nepali it is difficult to find exact homonyms. However, exemplars close to homonyms, differing only by a vowel or a consonant, were created like पनि, पानी, परिवार, परिकार

Aspiration: Aspiration in English is phonetic, whereas it is phonemic in Nepali. So, aspiration as a phonetic feature can create a phonemic difference in Nepali creating a separate lexical item. For example, पोहोर, फोहोर; गोडा, घोडा; गडी, घडी; करायो, खरायो; भिरालो, बिरालो

Phonemic characteristics of clustering on phonemic fluency trials in L2

First letters (words beginning with same first two letters, such as arm and art): Face, far; anatomy, anaconda, analogy

Rhymes (words that rhyme such as sand and stand): signal, symbol; alloy, annoy; shy, sky

First and last sounds (words differing only by a vowel sound, regardless of the actual spelling such as sat, seat, sight and sought): feel, fuel; sleep, slipper; homonyms (words with two or more different spellings, such as some and sum): falls, false; see, sea

Clustering in Semantic Fluency Trials in L1 and L2

Clustering in semantic fluency trials operated more or less in similar manner in both L1 and L2 which consisted of successively generated words belonging to the same subcategories which are, for example (in case of animal categories), organized by living environment (for example, domestic animals: बिरालो (cat), कुकुर (dog), गाई (cow), भैंसी (buffalo), and wild animals: फट्याङ्ग्रो (grasshopper), सर्प (snake), कालिज (pheasant), हरिण (deer)), human use (for example, among domestic animals बिरालो, कुकुर as pets and गाई, भैंसी as animals for milk) and zoological categories (for example, गाई (cow), भैंसी (buffalo) as mammals, फट्याङ्ग्रो (grasshopper) as insect, सर्प (snake) as reptile.

Switching

According to Troyer and colleagues (1997), "switching may be related primarily to participant's ability to disengage from a previous strategy or subcategory and would thus be impaired by preservative behavior". Herein lies the explanation to executive control in verbal fluency task (please see Green and Abutalebi (2013)'s Adaptive Control Hypothesis for task engagement and task disengagement as a cognitive control mechanism). Let's take example from both phonetic and semantic verbal fluency. While creating exemplars from 'f' in L2 phonetic fluency task, participant 1 generated: fruit, flower, face, far, forth, feel, fuel, farm, further, future, fame, fat, further, following. The first two exemplars have liquid sounds /r/ and /l/, the second two start with 'fa-', the next cluster 'far' and 'forth' have similar syllable, feel and fuel begin and end with 'f' and 'l'. Thus. There is a clear clustering and switching patterns and the switching pattern reveals strategy disengagement from the previous cluster and moving on to the next strategy and creating a new cluster. On a closer look, this pattern is discerned in L1 phonetic fluency as well. Likewise, in L2 semantic fluency for the animal category, the same participant produced: cat, dog, lion, tiger, giraffe, rat, donkey, monkey, elephant, zebra, squirrel, mongos, ant, octopus, earthworm, starfish, jellyfish, cow, leopard, frog, snake, camel, horse. In these exemplars, the participant produced the first two items as 'cat' and 'dog' which fall under domestic subcategory, after which the participant disengaged from this subcategory and moved onto the subcategory of carnivorous wild animals, 'lion' and 'tiger', to herbivorous subcategory 'giraffe',

followed by 'rat', a rodent subcategory. 'Donkey' and 'monkey' form a rhyming cluster and switch from a rodent to rhyming subcategory.

Errors

The participants are instructed to produce the exemplars under each trial within a given time of 60 seconds and not to repeat the word, not to name numbers, proper nouns, not to produce plurals or derivatives of the same word. Still, participants make such errors as can be noticed in the example exemplars presented in tables 1 – 4. Some of the examples of errors in L1 Phonetic fluency with

म: मैले, माछा, मलाई, म, मिना, मोती मास्टर, मिस्टर, महिलो, मकालु, माखा, मायालु, माया, माछापुच्छे, मुसा, मच्छेड, मधुरा, मखखन, मानिस, मान्छे There are many errors in these exemplars. For example, मैले, मलाई, म are the derivations of the same personal pronoun

म 'I', likewise, माछापुच्छे (fish tailed mountain) is derived from माछा (fish) and is also a proper noun which is not legitimate exemplar. Likewise, in मायालु (lovely) and माया (love). In मानिस, मान्छे, the same word मानिस is repeated twice and all three exemplars mean the same thing – man. मास्टर (master) and मिस्टर (mister) are actually English words, which is not legitimate exemplar.

Results: Verbal Fluency Task Performance

Verbal Fluency Task measures the ability of the participants to make words from the given letter or the category in L1 or L2. The mean score of Verbal Fluency Task as performed in both the languages by the participants has been calculated. The ability to produce the amount of words in a given condition is the signature of the ability in language production task.

Table 5

Phonetic Fluency

Item stimuli	No. of words	Switches	Cluster 0	Cluster 1	Cluster 2	Cluster 3	Cluster 4
क	11.6	10.56	9	1.55	1	1	1
प	11	10.08	8.84	1.93	1	1	1
म	10.48	9.36	7.6	2.22	1	1	0

Table 6

L2 Phonetic Fluency

Item stimuli	No. of words	Switches	Cluster 0	Cluster 1	Cluster 2	Cluster 3	Cluster 4
F	12.44	10.84	8.84	1.74	1	1	1
A	12.12	10.36	8.48	1.55	1	1	1
S	13.72	11.36	9.16	2.29	1.4	1.5	1

Table 7

L1 Semantic Fluency

Item stimuli	No. of words	Switches	Cluster 0	Cluster 1	Cluster 2	Cluster 3	Cluster 4
जनावर	15.16	11.8	8.12	2.96	1.06	1	0
फल	11.2	10.08	6.92	2.35	1.3	1	0
लुगा	13.68	10.76	7.84	2.65	1.2	1	0
तरकारी	12.4	11.12	8.52	2.5	1	1	0
फूल	5.6	5.04	4.4	1.3	1	0	0

Table 8

L2 Semantic Fluency

Item stimuli	No. of words	Switches	Cluster 0	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Animal	16.72	13.8	10.56	3.04	1.5	0	0
Fruit	9.72	8.16	6.6	1.71	1.25	0	0
Clothes	14.12	11.64	8.44	3.83	1	1	0
Vegetable	8.92	7.48	5.24	2.41	1	1	0
Flower	5.64	5.2	4.68	1.3	0	0	0

Discussion and Conclusion

In this study, we investigated the pattern of clustering and switching as cognitive control mechanism in Nepali-English healthy adult bilinguals. In L1 phonetic fluency task, participants performed better in L2 compared to L1 with consistently producing more exemplars in L2 in all the three given phonemes, even though they were different phonemes/letters. Likewise, in semantic fluency, participants produced more exemplars in L2 in animal and clothes category, equal number in flower category, whereas they produced more exemplars in fruit and vegetable category in L1 compared to L2. These findings are consistent with previous findings of bilingual advantage in verbal fluency task (Pathak et al, 2021; Pathak & Rijal, 2022). They had more clusters in phonetic fluency compared to semantic fluency in both L1 and L2 which indicates participants needed to disengage from the previous strategy or subcategory and move on to the next strategy or subcategory, thus, reflecting more cognitive demand imposed by the phonetic fluency compared to semantic fluency. The range of clusters were from 0 – 4, which means the clusters were of one word to five words. The largest clusters were of zero size, which comprised of one word cluster. There was no cluster size of 4 in L1 phonetic vft for, whereas the other phonemes had some clusters of size 4. L2 semantic fluency had the least variation of clusters with the size ranging from 0 – 2, except in flower category which had only two cluster of size 0 and 1.

Since the participants were college undergraduates and were mostly fluent in English, their performance in L2 verbal fluency task outnumbers the exemplars in L2 compared to L1. This shows verbal fluency task can also be used to measure the language dominance among bilinguals (see Pathak et al, 2024 for the use of verbal fluency task in measuring language dominance in trilinguals). An interesting area of investigation is also the error rates of the participants. Even though participants are instructed clearly what exemplars they are allowed and what they are not allowed, still they make errors. These errors are indicative of the automaticity and generative nature of language and also indicative of the organizational network of the language in our mental lexicon. Words are triggered based on the forms and functions. This is indicated in the way they make errors, the way they cluster and the way they switch.

In the recent days, interest has been growing on the implementation of mother tongue education and mother-tongue based multilingual education in Nepal (Yadava and Awasthi 2020, Pathak 2019). Language Policy Recommendation Commission of Nepal in 1994 (see Dhakal 2007) recommended for the inclusion of mother tongue as the subject and medium of instruction and paved the way for mother-tongue based multilingual education (MLE) in Nepal. Government of Nepal has created provisions for multilingual education by issuing guidelines for mother tongue based multilingual education implementation (DoE 2009). Yadava (2020) outlines the importance of considering sociolinguistic factors and language typology and appropriate pedagogies for implementation

of MLE. The benefits of bilingual education on wellbeing and higher academic performances by individual students have also been recognized recently (Awasthi 2020). So, there is a need to look for and consider alternative models of multilingual education (MLE) that will help in successful implementation of MLE in the country (Dhakal 2020).

Significance and originality

This is the first study investigating clustering and switching as cognitive control in Nepali-English healthy adult bilinguals. Second and third co-authors worked as research assistants under the first author, so this study also served as a training material for the interns working in the lab. We hope this will serve the similar purpose in other lab as well in training RAs in verbal fluency task. We also have made contribution in extending the field of cognitive science and psycholinguistics in Nepal (Pathak, 2022a; Pathak, 2022b; Pathak, 2023) through this study.

Limitation and Future Direction

This study was conducted on the Nepali-English bilingual college students in the campus, future studies on verbal fluency task should also encompass wider population for greater degree of ecological validity. The analysis has been done as within-subject performance without ANOVA and t-test, or correlation and regression analysis. Future studies should consider these analyses, with between-subject measures.

Verbal fluency task is a neuropsychological task administered on typical as well as atypical population to measure linguistic and cognitive performance. This study may further be extended to include more diversified population in terms of age, language family, typicality and ethnicity as independent variables.

Funding

References

Awasthi, Lava, D. (2020). Mother tongue medium education in Nepal: Approaches and viewpoints. In Yadava, Yogendra. P. and Awasthi, Lava. D. (Eds.). *Perspectives on Mother Tongue Based Multilingual Education in Nepal*. Kathmandu: Nepal Academy.

Central Bureau of Statistics .(2014). *Population Monograph of Nepal*. Central Bureau of Statistics: Kathmandu.

Dhakal, Dubi, N. (translation) (2007). *The report of National Languages Policy Recommendation Commission* (*2007*). Kathmandu: Central Department of Linguistics.

Dhakal, Dubi, N. (2020). Multilingual education in Nepal: Retrospect and prospect. In Yadava, Y. P. & Awasthi, L. D. (Eds.) 2020. *Perspectives on Mother Tongue Based Multilingual Education in Nepal*. Kathmandu: Nepal Academy

Eng, N., Vonk, J. M., Salzberger, M., & Yoo, N. (2019). A cross-linguistic comparison of category and letter fluency: Mandarin and English. *Quarterly Journal of Experimental Psychology, 72*(3), 651-660. https://doi.org/10.1177/1747021818765997

Friesen DC, Luo L, Luk G, Bialystok E. (2015). Proficiency and control in verbal fluency performance across the lifespan for Monolinguals and Bilinguals. *Lang Cogn Neurosci*,*30*(3), 238–250. https://doi.org/10.1080/23273798.2014.918630

Green, D. W., & Abutalebi, J. (2013). Language control in bilinguals: The adaptive control hypothesis. *Journal of Cognitive Psychology, 25*(5), 515–530. https://doi.org/10.1080/20445911.2013.796377

Kormi-Nouri R, Moradi AR, Moradi S, Akbari-Zardkhaneh S & Zahedian H (2012) The effect of bilingualism on letter and category fluency tasks in primary school children: Advantage or disadvantage? Bilingualism: Language and Cognition, 15(2) 351–364.

Luo L., Luk G., & Bialystok E. (2010) Effect of language proficiency and executive control on verbal fluency performance in bilinguals. *Cognition*, *114*(1), 29–41. https://doi.org/10.1016/j.cognition.2009.08.014

Pathak, L. S., Vulchanova, M., Pathak, P., & Mishra, R. K. (2024). Trilingual parallel processing: Do the dominant languages grab all the attention? *Bilingualism: Language and Cognition*, 1–18. https://doi.org/10.1017/S1366728924000257

Pathak, L. S. (2023). Sangyanatmak bigyan baaTa Nepal ko Parichay (Introducing Nepal through Cognitive Science). *Gorkhapatra National Daily*. https://www.gorkhapatraonline.com/news/85063

Pathak, L.S. (2019) "Nepalma bahubhashik shikshyaka jatilta" (complexities of multilingual education in Nepal). *Nayapatrika National Daily*. https://www.nayapatrikadaily.com/news-details/30006/2019-11-28

Pathak, L.S., Rijal, S. & Pathak, P. (2021). Instruction in second language enhances linguistic and cognitive abilities in first language as well: evidence from public school education in Nepal. *J Cult Cogn Sci 5*, 287–310. https://doi.org/10.1007/s41809-021-00084-7

Pathak, L. S., & Pathak, P. (2022). Bilingual Stroop Effect in High and Low Proficient Nepali-English Bilinguals. *Nepalese Linguistics, 35*(1), 128–136. https://doi.org/10.3126/nl.v35i01.46570

Pathak, L. S., & Rijal, S. (2022). A Study on Bilingual Verbal Fluency Task to Measure the Effect of Instruction in First and Second Language Performance. *Nepalese Linguistics, 36*(1),53–61. https://doi.org/10.3126/nl.v36i1.49458

Pathak, L. S. (2022). Initiating and Institutionalizing Cognitive Science and Psycholinguistics in Nepal: A Report. *Gipan, 5*(1), 52–62. https://doi.org/10.3126/gipan.v5i1.49542

Pathak, L. S. (2022). Activating Three Languages Simultaneously in Mental Lexicon: An Investigation of Nepali – English – Sanskrit Parallel Language Activation. *Tribhuvan University Journal, 37*(02), 48–70. https://doi.org/10.3126/tuj.v37i02.51649

Portocarrero JS, Burright RG & Donovick PJ (2007) Vocabulary and verbal fluency of bilingual and monolingual college students. *Archives of Clinical Neuropsychology 22*(3), 415–422.

Sandoval, T. C., Gollan, T. H., Ferreira, V. S., & Salmon, D. P. (2010). What causes the bilingual disadvantage in verbal fluency? The dual-task analogy. *Bilingualism: Language and Cognition, 13*(2), 231–252.

Troyer, A. K., Moscovitch, M., & Winocur, G. (1997). Clustering and switching as two components of verbal fluency: Evidence from younger and older healthy adults. *Neuropsychology, 11*(1), 138–146. https://doi.org/10.1037/0894-4105.11.1.138

Whiteside, D. M., Kealey, T., Semla, M., Luu, H., Rice, L., Basso, M. R., & Roper, B. (2015). Verbal Fluency: Language or Executive Function Measure? *Applied Neuropsychology: Adult, 23*(1), 29–34. https://doi.org/10.1080/23279095.2015.1004574

Yadava, Y.P. (2020). Envisaging a framework for mother tongue-based multilingual education (MTB MLE) in the federal context of Nepal:. In Yadava, Yogendra. P. and Awasthi, Lava. D. (Eds.). 2020. *Perspectives on Mother Tongue Based Multilingual Education in Nepal*. Nepal Academy.

Yadava, Y. P. & Awasthi, L. D. (Eds.). (2020). *Perspectives on Mother Tongue Based Multilingual Education in Nepal*. Nepal Academy.

◆◆◆◆