Concentric: Studies in Linguistics
39.2 (November 2013): 83-111 DOI: 10.6241/concentric.ling.39.2.04

Semantic Categorization in Prader-Willi Syndrome: A Case Study in Chinese*

Li-chi Elvis Yang
Shiao-hui Chan†
National Taiwan Normal University

Prader-Willi Syndrome (PWS), a multiple genetic anomaly disorder, is mainly associated with mild to moderate mental retardation. The purpose of the present study was to investigate the intactness of a PWS patient's (AH) conceptual structure through "taxonomical hierarchy" and "prototypicality", two vital dimensions capturing the external and internal structure of semantic categorization. Two experiments with linguistic and non-linguistic conceptual tasks revealed that the patient's performance was much poorer than that of the mental age-matched normal controls. Further corroborated by follow-up qualitative interviews, AH's incompleteness in her taxonomical hierarchy and deficiencies in the semantic representations were demonstrated in some exemplars under certain categories. However, prototypicality in AH was manifest to a certain degree in categories of which AH had better knowledge. Other linguistic impairment not directly related to hierarchy and prototypicality was also observed, evidencing the incompleteness of her conceptual knowledge as opposed to that of normal controls.

Key words: Prader-Willi Syndrome (PWS), semantic categorization, taxonomical hierarchy, prototypicality effects, Chinese

1. Introduction

Language impairment in patients with developmental disorders has attracted much attention in the past years (e.g. Specific Language Impairment: Gopnik & Crago 1991; Williams Syndrome: Bellugi, Bihrle, Neville, Doherty & Jernigan 1992, Neville, Mills & Bellugi 1994, Nazzi, Paterson & Karmiloff-Smith 2003; Down Syndrome: Chapman 1997, Roberts, Price & Malkin 2007). However, Prader-Willi Syndrome (hereafter PWS), also a developmental disorder, somehow received much less attention, especially in Chinese speaking societies. PWS is a neuro-developmental genetic disorder with an incidence estimated at 1:5000 to 1:25000 (Prader, Labhart & Willi 1956, Holm, Sulzbacher & Pipes 1981, Cassidy & Driscoll 2009). It is characterized by a diversity of clinical features and craniofacial anomalies: hypotonia (weak muscle tone), hypogonadism (genital deficit), hypopigmentation (pale skin color), hyperphagia (lack of satiety) and obesity, short stature, sleeping abnormalities,

* This research was supported by National Science Council (NSC), Taiwan, R.O.C. (NSC 101-2410-H-003-075-), the "Aim for the Top University Project" of National Taiwan Normal University (NTNU), sponsored by the Ministry of Education, Taiwan, and the "International Research-Intensive Center of Excellence Program" of NTNU and NSC (NSC 103-2911-I-003-301). We would like to thank the two anonymous reviewers for their insightful comments on an earlier version of this paper.
† Corresponding author: shiaohui@ntnu.edu.tw.

high mortality, a small forehead, a small mouth, almond-shaped eyes, etc. Since PWS was recognized as a distinct genetic syndrome, a plethora of studies have been conducted on the medical, genetic and behavioral (cognitive/intellectual/psychological) aspects of the syndrome (Conners, Rosenquist, Atwell & Klinger 2000, Butler, Bittel, Kibiryeva, Talebizadeh & Thompson 2004, Cassidy & Driscoll 2009). Also observed are the psychological or cognitive deficiencies, such as behavioral/psychiatric disturbances (compulsiveness, stubbornness, and irascibility), developmental/cognitive delays (tardy gross motor and language milestones) (Cassidy 1984, Holm, Cassidy, Butler, Hanchett, Greenswag, Whitman & Greenberg 1993, Cassidy 1997, Cassidy & Driscoll 2009), depressed intellectual functioning (Prader, Labhart & Willi 1956, Dunn 1968, Zellweger, Schneider & Johannsson 1968), relatively superior long-term memory with inferior short-term memory (Warren & Hunt 1981, Conners, Rosenquist, Atwell & Klinger 2000), relatively superior visual processing with inferior auditory perception (Taylor & Caldwell 1983, Curfs, Wiegers, Sommers, Borghgraef & Fryns 1991, Dykens 2002, Stauder, Brinkman & Curfs 2002), deficits in higher-order processing (abstract-thinking, executive, metacognitive and generalizing disabilities) (Sullivan & Tager-Flusberg 2000, Tager-Flusberg & Sullivan 2000, Whitman & Thompson 2006), and, above all, mild to moderate mental retardation (Holm 1981, Curfs & Fryns 1992).

Mental retardation not only hampers the general cognitive abilities but also throttles the language/speech development in PWS (Munson-Davis 1988, Åkefeldt, Åkefeldt & Gillberg 1997). Generally, PWS individuals' speech is often associated with a harsh voice quality, hyper- or hyponasality, malfunctioned prosody, phonetic/phonological errors, flaccid dysarthria (i.e. hypotonia-induced articulatory imprecision or irregularities) (Lewis 2006), dysarthria-triggered unintelligibility (Zellweger 1979), developmental apraxia of speech (Branson 1981, Munson-Davis 1988), and dysfluency (repetitions, additions, and circumlocution created by word-recall difficulties) (Branson 1981, Kleppe, Katayama, Shipley & Foushee 1990). In addition, inadequacies in vocabulary (use of more content words than functional words) (Kleppe, Katayama, Shipley & Foushee 1990), word usage, grammar (structural incompleteness) (Prader-Willi Syndrome Association 1980a), morphology (advanced allomorphic difficulties) (Kleppe, Katayama, Shipley & Foushee 1990), discourse (narrative difficulties) (Lewis, Freebairn, Sieg & Cassidy 2000), pragmatics (inference/connotation/speech acts disabilities) (Whitman & Thompson 2006), and language acquisition (retarded language milestones) (Hall & Smith 1972, Prader-Willi Syndrome Association 1980b, Lewis 2006) are also reported. Expressive language skills are usually inferior to receptive skills (Branson 1981, Munson-Davis 1988, Kleppe, Katayama, Shipley & Foushee 1990, Lewis, Freebairn, Heeger & Cassidy 2002).

Although many aspects of language have been explored, the amount of literature on conceptual systems in PWS individuals is somehow still a drop in the bucket. Conceptual systems play a significant part in the efficient functioning of human cognition, where concepts are well-organized as bundles of stored knowledge, gained and accumulated through a diversity of events, entities, situations, and so forth in our experience (Cruse 1986). The reason why we are able to acquire new ideas from each fresh, unique experience is that we put similar elements of experience into “semantic categories” so that we can recognize them as having occurred before, and then we can access stored knowledge about them (Cruse 1986, 2004). Such semantic categorization is a central cognitive ability, through which we can group together a variety of instances into a unitary concept (Tager-Flusberg 1985a). Research has shown that two important features exist among representations of semantic categorization: hierarchy and prototypicality (Rosch 1973, 1975, Rosch & Mervis 1975, Rosch, Mervis, Gray, Johnson & Boyes-Braem 1976).

Hierarchy exists in two types of conceptual systems: taxonomies and partonomies (Barsalou 1992). In the former, concepts are organized by the type relation (e.g. *plant, tree, pine*), while in the latter, they are organized by the part relation (e.g. *car, engine, carburetor*). Even though these two differ in their organizing relations, they both exhibit hierarchical structure: each concept dominates/encompasses more specific concepts, which in turn dominate/encompass still more specific concepts, and so on. We will focus on the taxonomies in this study. A hierarchical taxonomy can be characterized in terms of the relation of dominance (Cruse 1986, 1990, 1994, 2004). For example, the superordinate category, ANIMAL, immediately dominates two basic level categories, *dog* and *cat*, which in turn dominate subdivisions, e.g. Collies, Alsatians, and Pekinese (under a *dog* category). However, the boundaries between basic level categories and non-basic level categories (superordinate and subordinate categories) are usually vague. It is generally agreed that basic level categories (e.g. *dog, cat, elephant*) are the most inclusive categories whose members (e.g. Collies, Pekinese) own significant numbers of attributes in common (Rosch 1973, 1975, Rosch & Mervis 1975, Rosch, Mervis, Gray, Johnson & Boyes-Braem 1976).

While taxonomical hierarchy has to do with the external structure of a category, prototypicality has to do with the internal structure of a category. Prototypicality is the idea that the internal structure of a category is systematically structured around the ‘best’ examples, or ‘prototypes’, of categories, and other less central items are assimilated to a category according to whether they sufficiently resemble the prototype(s) or not (Rosch 1973, 1975, Rosch & Mervis 1975, Rosch, Mervis, Gray, Johnson & Boyes-Braem 1976). To quantify the prototypicality of an item within a category, one can use subjects' Goodness-of-exemplar (GOE) ratings (Rosch 1973). In such ratings, subjects are asked to rate whether an item is a good or bad example of a category. However, GOE is not always a reliable rating technique due to its high dependency on culture. For example, *date* is typically rated low on the GOE scale in a British context, but it is rated high among Jordanian participants under a FRUIT category (Cruse 2004).

There is substantial evidence showing that prototypicality has a strong correlation with some aspects of human cognitive behavior, including order of mention, order of acquisition, speed of verification, etc. (Cruse 1986, 1990, 1994, 2004). Order of mention is often tested when subjects are asked to list members of a certain category under time pressure and subjects usually list the most prototypical example(s) first; order of acquisition is that children tend to acquire/pick up the prototypical members of categories earlier; speed of verification is usually presented by psychological experiments in which subjects react faster if the experimental stimuli are prototypical members.

In a nutshell, "taxonomical hierarchy" and "prototypicality" capture the external and internal structure of semantic categories, respectively. The purpose of the present study was to use these two factors to examine the intactness of a PWS patient's conceptual structure against that of normal people. From the considerable literature of the impairments of linguistic and non-linguistic functioning in PWS reviewed above, we hypothesized that this PWS patient might also have problems in the conceptual systems. Two behavioral experiments will be reported in this paper. Within each experiment, the methods, results and discussion will be presented in that order. A general summary and discussion will be given after the presentation of the two experiments followed by a conclusion.

2. Experiment 1: Taxonomical hierarchy in PWS

The purpose of the experiment was to examine the taxonomical hierarchy in PWS with non-linguistic materials.

2.1 Methods

2.1.1 Participants

The participants were a female PWS patient (AH) (chronological age = 20; mental age = 9, determined with WAIS-III by a certified clinical psychologist) and 26 normal controls (mean age = 9.2, ranging from 8;10 to 9;7). The controls were from an elementary school in Taipei and had no history of psycho-neurological disorder or learning disability. All the participants were native speakers of Mandarin Chinese. Oral consent from the patient's mother and her elder brother and written consent from the normal controls' guardians were obtained before the experiment.

2.1.2 Stimuli

The stimuli contained line-drawings of basic level objects from 9 superordinate categories, including ANIMAL (動物類), FRUIT (水果類), CLOTHING (衣著類), MUSICAL INSTRUMENT (樂器類), FOWL (禽鳥類), TOOL (工具類), VEHICLE (交通工具類), VEGETABLE (蔬菜類), and INSECT (昆蟲類). The selection of the superordinate categories and their corresponding basic level categories were based on previous categorization literature, including 6 superordinate categories from Rosch & Mervis (1975) and 15 superordinate ones from Snodgrass & Vanderwart (1980), which added up to 13 superordinate categories after excluding meronomy (holonymy) categories, such as "Part of the Human Body", and the overlapping categories listed in both sources. Nine out of the 13 superordinate categories were then constructed with their corresponding basic level line-drawings stimuli selected from Snodgrass & Vanderwart (1980) and International Picture Naming Project at CRL-UCSD[1]. The reason that only nine categories were selected was to well-utilize the objects (253 items available in the pool) so that each category included enough exemplars for the experimental manipulation and that all the stimuli only appeared once in the experiment.

An example trial is given in Figure 1 below.

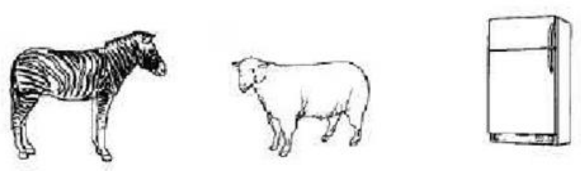

Figure 1. An example trial in Experiment 1

There were a total of 24 trials, in each of which three objects were arranged in a row. Two of the three objects were under the same category, with the other belonging to a different category. Each object appeared only once, making up a total of 72 (24×3)

[1] CRL-UCSD, the Center for Research in Language, University California San Diego, is devoted to immense international language study to provide "norms for timed picture naming" in seven different languages (American English, German, Mexican Spanish, Italian, Bulgarian, Hungarian, and the Mandarin Chinese spoken in Taiwan). Please refer to http://crl.ucsd.edu/~aszekely/ipnp/method/getpics/getpics.html for further details.

objects/pictures.

2.1.3 Procedure

The controls participated in the experiment in a computer classroom of their elementary school while the PWS patient participated in the experiment in a quiet room at the experimenter's place in the company of her elder brother, the patient's main care taker. The visual stimuli (i.e. three adjacent pictorial objects in each trial) were presented via DMDX, a psycholinguistic tool that presents stimuli and records the reaction times and accuracy rates of subjects (Forster and Forster 2003). The experimental task was a non-linguistic exclusion task where the subjects had to decide by button pressing which object among the presented stimuli did not belong to the same category. The non-linguistic exclusion task aimed to test whether the subjects had the representation (i.e. stored knowledge) of a taxonomical hierarchy for a concept/category (superordinate vs. basic level category) without taxing their linguistic knowledge about the labels/names of the categories.

Practice trials were given prior to the experiment until reliable performance was reached. Each trial began with a fixation point ("+") displayed for 800 ms in the middle of the screen, followed by a blank screen for 500 ms, and then three objects arranged in a row appeared. The time between the onset of the visual stimuli and the onset of the subjects' overt output (pressing the "left", "down", "right" key on the keyboard, which corresponded to "left", "center", "right" on the screen, respectively) was recorded by the computer as the reaction time (RT) and the error rates (ER) were also recorded. The trial order was randomized and the position of the objects were carefully arranged so that the probability of the appearance of the target/excluded object in the left, center, and right position was equal.

The normal controls had to respond within 8 sec; otherwise, the current trial would be erased from the screen and the next trial would start. The duration for the PWS patient was adjusted to 20 sec owing to her physical and mental retardations. Besides, the patient could not successfully use the keys to present her answers after instructions; therefore, the patient's brother helped her to press the keys immediately after she made an overt response by pointing at the picture on the screen or naming the object. There was some lapse between AH's overt response and her brother's button press, but the lapse was less than 100 ms (measured from the practice trials). Besides, the aid from her brother was essential, without which AH' data would not have been successfully collected.

After the online experiment, an interview with the PWS patient was conducted a week later in the company of the patient's elder brother. The whole session was tape-recorded and the data were analyzed after the interview.

2.2 Results

AH's reaction time (4867 ms) was longer and her error rate (54%) was higher than those of the normal controls. Specifically, AH's RT and error rate were below 2 standard deviations (SDs) of the normal means (RT: z = 3.83; error rate: z = 4.61), as shown in Table 1.

Table 1. Error Rates (%) and Response Times (ms) of the Normal Controls and AH (standard deviation in the parentheses)

	Error Rate (SD)		Response Time (SD)	
Subjects	Normals	AH	Normals	AH
Raw data	5 (4)	54 (14)*	2174 (446)	4867 (3065)
Z score		4.61		3.83

Note: * indicates that AH performance is below 2 SDs of the normal means.

In fact, when comparing AH's error rate and RT with the highest error rate and longest RT in the normal group, AH's performance was still poorer. The highest error rate among the controls was 17%, while AH's error rate was 54%. Also, the control's longest RT was 3106 ms while AH's RT was 4867 ms. In sum, it was clear that the error rate and RT of AH were respectively higher and longer than those of the normal controls, with AH's performance being below 2 SDs of the normal means.

To understand how AH's performance differed from the normals, we looked into her correct and incorrect trials. We found that the superordinate categories to which AH made correct responses were FRUIT, CLOTHING, MUSICAL INSTRUMENT, TOOL, and VEHICLE, while the categories, ANIMAL, FOWL, VEGETABLE, and INSECT, were the ones where she made erroneous decisions.

To further investigate the nature of AH's pattern, we conducted a follow-up interview a week after the experimental session. The purpose of the interview was to further explore: 1) AH's definitions of the original 13 superordinate categories, from which we selected 9 in the experiment, and 2) the rationale behind her decisions in performing the online task. The reason to ask AH about all the 13 categories, not just the 9 ones included, was to have a more thorough understanding of AH's problems. The interview commenced with a definitional task, with the superordinate category terms made into questions to examine whether or not AH had representation (stored knowledge) about these superordinates.

The definitional inquiries were simple questions, such as "What is a/an _____

(ANIMAL category)? (什麼是_____ (動物)?)" followed by some related follow-up questions, such as "Can we play with _____ (animals)? (_____ (動物)可不可以玩?)". Subsequently, AH was inquired about her decisions with the exclusion task with the 13 erroneous trials she made, for the elicitation of her taxonomical hierarchy. An example question was "Why did you exclude the _____(dove) from the group? (你為什麼要把_____ (鴿子)挑掉啊?)" Below is an excerpt of the definition data from the interview:

(Definition of the ANIMAL Category by AH)

Experimenter:	什麼是動物? *she me shi dongwu* 'What is an animal?'
AH:	動物… *dongwu* 'Animal…'
Experimenter:	你在馬祖有沒有看過什麼動物? *ni zai mazu you mei you kan guo sheme dongwu* 'Have you seen any animals in Mazu?'
AH:	馬祖，看到"狗"，"狗狗"… *mazu, kan dao gou gougou* 'Mazu, saw "dog", "doggie"…'
Experimenter:	狗狗是動物嗎? *gougou shi dongwu ma* 'Is a doggie an animal?'
AH:	(搖頭) (AH was shaking her head.)
Experimenter:	你喜不喜歡吃動物呢? *ni xi bu xihuan zhi dongwu ne* 'Do you like to eat animals?'
AH:	不行! *buxing* 'No way!
Experimenter:	不行吃動物，為什麼你不能吃動物? *buxing chi dongwu weisheme ni buneng chi dongwu* '(You) can't eat animals; why can't you eat animals?'
AH:	不行，不行吃… *Buxing buxing chi* 'No way! (We) cannot eat…'

Experimenter: 動物可不可以玩?
dongwu ke bu keyi wan
'Can we play with animals?'

AH: 玩，不可以玩動物…
wan, bu keyi wan dongwu
'Play? Can't play with animals…'

Experimenter: 動物可不可以陪你睡覺?
dongwu ke bu keyi pei ni shuijiao
'Can animals sleep with you?'

AH: 不行，因為跟牠會爬到我身上去
buxing yinwei ta hui pa dao wo shen shang qui
'No! Because they will climb upon me.'

Experimenter: 你最喜歡那種動物?
Ni zui xihuan na zhong dongwu
'What animal do you like best?'

AH: 獅子
shizi
'Lion'

Experimenter: 你最喜歡獅子，為什麼? 獅子牠有甚麼?
ni zui xihuan shizi weisheme shizi ta you sheme
'You like lions best; why? What does a lion have?'

AH: 獅子有兩隻腳…
shizi you liang zhi jiao
'A lion has two feet…'

The interview indicated that AH's knowledge of the superordinate categories was gradable—she seemed to know some categories better than the others. For example, she was quite familiar with FRUIT and CLOTHING, and she did well when asked to name the exemplars under these two categories. She could even name three to four basic level exemplars of FRUIT without much obstruction. However, as to ANIMAL, CUTLERY, TOOL, MUSICAL INSTRUMENT, FOWL, VEHICLE, TOY, VEGETABLE, and INSECT, she could only name one or two exemplars after pondering a while (as to the category MUSICAL INSTRUMENT, she pantomimed "playing" the piano). As to the rest of the categories—KITCHEN UTENSIL, FURNITURE, and WEAPON—she could barely define or give example(s). In sum, the interview about the definitions of the superordinate categories showed that AH had the stored knowledge about the concepts and names/labels of 10 out of the 13 tested superordinate categories (except for KITCHEN UTENSIL, FURNITURE, and

WEAPON).

We then further explored how AH performed the online exclusion task. By analyzing her online data, we found that when AH saw the categories that she knew well, she did as well as the normal controls; when she encountered categories that she had faint knowledge about, she seemed to ignore (or maybe did not even notice) the out-of-category object and then selected the object that she preferred or was more familiar to her. For example, one of the trials showed *fox*, *knife*, and *pig* under the ANIMAL category, and *knife* should be excluded. AH called *fox* a "dog", and *knife* a "bat/rod", and she could not name the picture of *pig*, although she seemed to recognize it. Then she chose between "dog" (actually it was a *fox*) and *pig* after ignoring the "bat/rod" for an unknown reason and finally selected "dog" (although *knife* should be excluded). Another example was the FOWL category. One of the trials showed *duck*, *rooster* and *stroller*. AH called *duck* a "dove", *rooster* a "gu-gu-gu (onomatopoeia)" and *stroller* "a car for little boys (小弟弟坐的車)". She then chose "dove" (actually it was a *duck*) as her final answer; AH's brother then said that there were many doves in Mazu (馬祖), where AH used to live and work for a long time. After AH chose *duck* (again, she thought it was a "dove") as the object that should be excluded from the group, we asked about her reason. As follows is the excerpt of the inquiry:

Experimenter: 你為什麼要把"鴿子"挑掉啊?
ni weishemo yao ba "gezi" tiao diao a
'Why do you exclude the "dove" from the group?'
AH: 因為牠不是跟我們同一國的啊…!
yinwei ta bushi gen women tong yi guo de a
'Because it is not in the same nation as we are
(i.e. because it doesn't belong to us)'
Experimenter: 哦!鴿子不是跟牠們同一國的，為什麼鴿子不是跟牠們同一國的啊?
o gezi bushi gen tamen tong yi guo de weishemo gezi bushi gen tamen tong yi guo de a
'Oh! The dove doesn't belong to them; why doesn't it belong to them?'
AH: 因為鴿子不是跟牠們同一國的啊…!
yinwei gezi bushi gen tamen tong yi guo de a
'Because the dove doesn't belong to them…!'

From the above conversation, it was clear that AH made a recursive answer to the question. In fact, she answered all the questions about her choice(s) in almost the same way; therefore, it was unlikely to figure out why she made some choices instead of others.

We also found two interesting phenomena that were frequently seen in child language acquisition: overextension and underextension. When asked to name each object in each trial, AH called both *fox* and *donkey* “dogs”. Any animal that resembled a dog was called a dog in AH’s language use. On the other hand, AH only recognized *spotted deer* (梅花鹿) as a deer but failed to recognize other kinds of deer pictures.

2.3 Discussion

We conducted Experiment 1 to explore taxonomical hierarchy in AH with an online, non-linguistic exclusion task. We found that AH performed poorer than the normal controls in terms of her longer reaction time and higher error rate. Detailed analysis on the items revealed that AH knew better about, for example, FRUIT and CLOTHING than about ANIMAL, FOWL, VEGETABLE, and INSECT. We then conducted a follow-up interview to test AH’s definitions of 13 superordinate categories and her rationale behind the decisions in performing the online exclusion task. We found that AH’s knowledge of the superordinate categories was gradable—she seemed to know some categories better than the others. With further probing, we discovered that the high error rate on the exclusion task might be attributed to her use of “familiarity” strategy in deciding which object to “exclude”—she sometimes chose objects that she was familiar with instead of excluding those that did not belong to the same category. However, this should not be interpreted as AH’s failure to understand the task. In fact, she knew that she had to pick out one object that was “different” from the other two, as indicated in the excerpt about “dove” described above; it was just that she used a different strategy in performing the task in some trials. Finally, AH also demonstrated over- and underextension in her output, showing that her conceptual knowledge of certain objects might not be as complete as that of normal controls.

3. Experiment 2: Taxonomical hierarchy and prototypicality in PWS

The purpose of Experiment 2 was to examine the taxonomical hierarchy and prototypicality in PWS with a cross-modal test, with the category name (i.e. the linguistic label of the tested category) as the auditory input and the exemplar picture as the visual stimulus.

3.1 Methods

3.1.1 Participants

All the participants in Experiment 1 participated in Experiment 2.

3.1.2 Stimuli

The materials consisted of 24 sets of stimuli, including 10 categories and 96 line-drawings of basic level objects. Each set of stimuli contained four objects varying in the degree of prototypicality within a particular category: central, peripheral, and two fillers, as shown in Figure 2 below. The central and peripheral objects were the basic level categories under the same superordinate category, and the two fillers were objects out of the category to which the central and peripheral ones belonged. For example, *leopard* and *snail* were the central and peripheral members of the ANIMAL category, respectively, and *salt shaker* and *high chair* served as fillers because they did not belong to ANIMAL. The prototypicality of the objects was determined by a pilot test. In this pilot test, 13 superordinate categories were selected from Rosch and Mervis (1975) and Snodgrass and Vanderwart (1980) (see Experiment 1 for details). Although prototypicality of the basic level objects was reported in these two studies, it was somewhat culture-biased. For example, in Snodgrass and Vanderwart's study, *watermelon* was ranked as the least prototypical exemplar in the superordinate category FRUIT, while watermelons appear to be a central one when it comes to fruits in Taiwan. This culture-induced mismatch in prototypicality triggered the necessity of a norming procedure before valid stimuli were created. A total of 253 objects along with their corresponding superordinate categories were created in Prototypicality questionnaires. GOE (Goodness-of-exemplar) ratings were adopted, with 5 being very typical and 1 being atypical. An option of "0" was also provided so that subjects could report the presented item as not being within that category. Each object in the questionnaires was rated by 50 students from one private university and one national university in Taipei; all the raters were over 18-year-old native speakers of Chinese, and they were college students of different majors. To make all/most the objects well-distributed among categories, 10 superordinate categories with 48 (24 central and 24 peripheral) basic level objects were finally selected: ANIMAL (動物類), FURNITURE (家具類), WEAPON (武器類), TOOL(工具類), CLOTHING(衣著類), MUSICAL INSTRUMENT(樂器類), VEHICLE (交通工具類), TOY (玩具類), VEGETABLE (蔬菜類), and INSECT(昆蟲類). The prototypicality rating for the 24 central objects was above 3.7 (out of 5) while that for the 24 peripheral objects were between 1.8 and 3.1. The average prototypicality rating for the centrals was significantly higher than that for the peripherals (4.63 vs. 2.46, $t(23) = 19.99$, $p < 0.001$).

In the end, 48 fillers were added so that a total of 96 (24×4) objects were selected for Experiment 2, including 24 centrals, 24 peripherals, and 48 fillers. None of the objects appeared in Experiment 1. The 96 objects were then put into 96 trials, each of which contained an auditory stimulus of a category name and a visual stimulus of the object picture, which is within (i.e. centrals and peripherals) or outside (i.e. fillers) the named category. The auditory stimuli were recorded by a male native speaker of Chinese and the audio clips of all trials were carefully examined by 2 raters to ensure the voice quality.

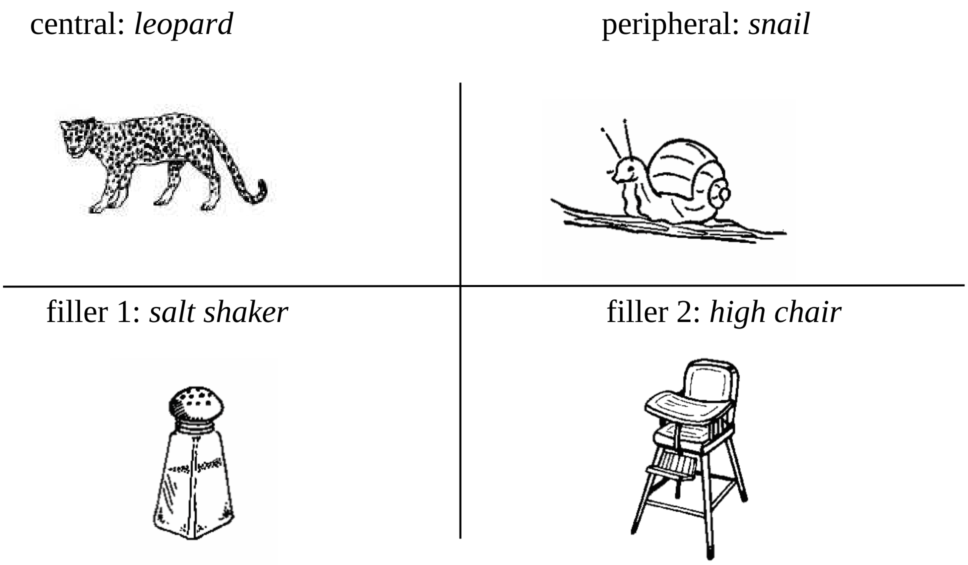

Figure 2. An example set in Experiment 2 (an auditory experiment on ANIMAL)

3.1.3 Procedure

The procedure was identical to that in Experiment 1 except for the material presentation and experimental task, which were described below. Each trial began with a fixation point ("+") displayed for 800 ms in the middle of the screen, followed by a blank screen for 500 ms. Then a sound clip was played, followed immediately by a visual picture. Subjects had to perform a cross-modal prototype decision task, in which they had to listen to a spoken category name and decide whether or not a presented object belonged to that category by pushing the "left" or "right" key on the keyboard. The key use was counterbalanced across subjects. All the trials were randomized within the experiment.

The time between the onset of the visual stimulus and the onset of the subjects' button press was recorded by the computer as the RT and accuracy rate. Within 3.5

sec, an overt key-pressing response should be made by the normal controls; otherwise, the stimuli would be erased from the screen and the next trial would start. As for the PWS patient, the duration was adjusted to 15 sec owing to her physical and mental retardations. As in Experiment 1, the patient could not successfully use the Yes and No keys to present her answers; therefore, the patient's brother helped her to press the keys as an expedient approach immediately after she made an overt response by saying Yes or No.

After the online experiment, an interview with the PWS patient was conducted a week later with the patient's brother's company. The whole session was tape-recorded and the data were analyzed after the interview.

3.2 Results

Before we analyzed the behavioral results, it immediately became clear that the average error rate for the peripheral condition was unexpectedly high in the normal controls (59%). With careful examination, we found that the high error rate was due to the mismatch/disagreement in prototypicality between the adult raters in the pilot test and the 9-year-old normal controls in the experiment. In Table 2, the children's error rates (including unexpected responses or "no response", i.e. items that subjects did not make any response to within the time constraint) and the adult raters' responses in the pilot test were reported. Take *lizard* (蜥蜴) as an example. Five out of 26 subjects (19%) made a mistake on this one, while only 3 out of 50 adult raters (6%) gave the value "zero", indicating that they did not think this item belonged to the superordinate category. A quotient was calculated by dividing children's error rate by the adult rater's "zero response" to demonstrate how different the two values were (see Table 2). The quotients revealed that there were indeed disagreements between children and adults on more than half of the peripheral items.

Table 2. The Error Rates of the Twenty-four peripheral objects in the normal controls (Children) vs. the rate of zeros given by adult raters in the Pilot Test (Adults). The difference (Quotient) between the two values were derived by dividing children's error rate by the adult rater's "zero" response. The number under each peripheral object is its prototypicality rating.

Superordinate Category	**動物類 ANIMAL**	**動物類 ANIMAL**	**動物類 ANIMAL**	**家具類 FURNITURE**
Peripheral Object	蜥蜴 *lizard* 2.86	蝸牛 *snail* 2.2	章魚 *octopus* 2.32	花瓶 *vase* 2.34
Children	19%	27%	12%	42%
Adults	6%	8%	6%	8%

Quotient	3.17	3.38	2.00	5.25
Superordinate	**家具類**	**家具類**	**武器類**	**武器類**
Category	**FURNITURE**	**FURNITURE**	**WEAPON**	**WEAPON**
Peripheral	唱片放奏機	嬰兒床	瓶子	潛水艇
Object	*record player*	*baby crib*	*bottle*	*submarine*
	2.42	2.06	2.02	2.52
Children	96%	12%	100%	92%
Adults	8%	14%	16%	12%
Quotient	12.00	0.86	6.25	7.67
Superordinate	**武器類**	**工具類**	**工具類**	**工具類**
Category	**WEAPON**	**TOOL**	**TOOL**	**TOOL**
Peripheral	球棒	水管	乾草叉	針
Object	*bat*	*hose*	*hayfork*	*needle*
	2.94	2.78	2.94	2.92
Children	88%	50%	35%	81%
Adults	10%	6%	4%	0
Quotient	8.80	8.33	8.75	
Superordinate	**衣著類**	**衣著類**	**衣著類**	**衣著類**
Category	**CLOTHING**	**CLOTHING**	**CLOTHING**	**CLOTHING**
Peripheral	背包	手提包	手錶	手套
Object	*backpack*	*handbag*	*watch*	*glove*
	2.2	2	2.48	2.96
Children	96%	96%	92%	85%
Adults	12%	16%	6%	2%
Quotient	8.00	6.00	15.33	41.00
Superordinate	**衣著類**	**樂器類**	**交通工具類**	**交通工具類**
Category	**CLOTHING**	**MUSICAL INSTRUMENT**	**VEHICLE**	**VEHICLE**
Peripheral	室內拖鞋	鈴鐺	雪橇	單輪腳踏車
Object	*slipper*	*bell*	*sled*	*unicycle*
	1.9	2.34	2.72	1.86
Children	58%	42%	77%	35%
Adults	18%	8%	4%	30%
Quotient	3.22	5.25	19.25	1.17
Superordinate	**玩具類**	**蔬菜類**	**蔬菜類**	**昆蟲類**
Category	**TOY**	**VEGETABLE**	**VEGETABLE**	**INSECT**
Peripheral	網球拍	蕃茄	花生	蚯蚓
Object	*tennis bat*	*tomato*	*peanut*	*earthworm*
	2.9	3.04	2.26	2.08
Children	81%	8%	65%	35%
Adults	2%	4%	8%	24%
Quotient	40.50	2.00	8.13	1.46

To decrease the mismatch between the normal controls and the adult raters so that further analysis could be conducted, we selected those peripheral objects whose error rates were smaller than/equal to 50%. Eleven out of the 24 peripherals were preserved, including, *lizard* (蜥蜴), *snail* (蝸牛), *octopus* (章魚), *vase* (花瓶), *baby crib* (嬰兒

床), *hose* (水管), *hayfork* (乾草叉), *bell* (鈴鐺), *unicycle* (單輪腳踏車), *tomato* (蕃茄), and *earthworm* (蚯蚓). The selection of the 11 objects reduced subjects' average error rate for peripherals from the original 59% to 29%. To match the number of the peripherals, 11 centrals and 22 fillers were randomly selected for further analysis.

For the normal controls, repeated-measures ANOVAs were conducted to test the prototypicality effects under the central, peripheral, and filler conditions. An alpha value of 0.05 (two-tailed) was adopted, with the Greenhouse-Geisser correction applied when appropriate. For follow-up paired t-tests, a two-tailed alpha level of 0.05 was chosen. There was a main effect of prototypicality in error rate, $F(1.49, 36.44) = 24.47$, $p < 0.001$, and in RT, $F(1.46, 36.58) = 15.98$, $p < 0.001$. Follow-up paired t-tests revealed that the error rate for the peripherals was higher than that for the centrals, $t\ (25) = -5.17$, $p < 0.001$, and the fillers, $t\ (25) = 5.41$, $p < 0.001$, respectively. The error rate difference between the fillers and the centrals was not significant, $t\ (25) = -0.83$, $p=0.414$. The *t*-tests further revealed that the RT for the peripherals was longer than that for the centrals or the fillers, $t\ (25) = -4.83$, $p < 0.001$; $t\ (25) = 2.87$, $p < 0.01$. The RT for the fillers was longer than that for the centrals, $t\ (25) = 3.86$, $p < 0.01$. In sum, the prototypicality effects manifested themselves in the normal controls' conceptual systems—they made fewer errors and responded faster to the centrals than to the peripherals or fillers. The effect also indicated that our manipulation of the prototypicality of materials was indeed effective.

As for AH, her performance was generally poorer than that of the 26 normal controls across the three conditions, as demonstrated in her longer RTs and higher error rates. She did show the prototypicality effect by responding more correctly to centrals than to peripherals (error rate: centrals: 55%; peripherals: 91%); however, there were not enough data points for analysis on the RTs. We then compared AH's performance with the average of the normal controls. For the basic level items (centrals and peripherals), AH's error rate was out of two standard deviations (SDs) of the normal controls (centrals: $z = 3.29$; peripherals: $z = 2.42$), showing that her performance was far below that of the normal controls. Her error rate for the filler condition was 14%, which was still below 1 SD of the normal mean ($z = 1.50$). AH's RTs for centrals and peripherals were also below 2 SDs of the normal controls' mean; however, due to the high error rate for the centrals (55%) and peripherals (91%), the comparison was not too meaningful (only 5 and 1 data points were left for the central and peripheral conditions, respectively). Her RT for fillers was below 1 SD ($z = 1.99$). The results are summarized in Table 3.

Table 3. Error Rates and Response Times of the Normal Controls and AH

Condition	Error Rate (%) (SD)		Response Time (ms) (SD)	
	Normals	AH	Normals	AH
central	7 (11)	55 (29)*	1510 (291)	3621(2091)§
peripheral	29 (22)	91 (73)*	1846 (444)	3263(2734)§
filler	5 (5)	14 (16)	1655 (285)	2284(2226)*

Note: Number in the parenthesis indicates standard deviation. * indicates that AH performance is below 2 SDs of the normal means; § indicates that the data point is not representative due to AH's small number of correct trials (3621 ms was the RT average of five correct trials and 3263 from only one correct trial).

As in Experiment 1, we conducted a follow-up interview a week after the experimental session to further evaluate the central and peripheral trials in which AH made mistakes in Experiment 2. AH was asked to re-undertake the prototype task with 12 central and 22 peripheral trials in Experiment 2 as the stimuli. This time she was not timed so she could take as much time as she wanted to make responses. Then she was inquired with a list of categorization questions, such as "Is _____ (a giraffe) an animal? (_____ (長頸鹿)是動物嗎?)". From the re-performance of Experiment 2, we found that AH indeed lacked the stored knowledge about some the superordinate categories. For example, she did not think the central object *rocking chair* (搖椅) belonged to the FURNITURE category in the online experiment, and neither did she think so in the interview. And some other examples further showed that she did not know what FURNITURE really was; e.g., she thought that *horse* was a piece of furniture. There were some trials (e.g. *giraffe, snail, saw, doll, bee*) where she disagreed in the online experiment but changed her mind in the qualitative interview, showing that her high error rate in the online experiment might partially be due to the time pressure, not entirely to her lack of knowledge of taxonomical hierarchy and categorization.

Interestingly, AH seemed to show more problems in lower-to-higher hierarchical processing than the other way around. While she was asked what ANIMAL was, she gave *dog/doggy* (狗狗) as a response. However, when further asked, "Is a dog an animal", she hesitated even though *dog* is a very typical exemplar of ANIMAL. We also found that AH had naming difficulty because she tended to use circumlocutions to describe what she was seeing. For example, when seeing *vase*, she said, "Glass, to add some water, and put some flowers in… (玻璃；要用水，將花放下去啊…)"; when seeing *lizard*, she said "something that crawls (會爬的)" instead of *lizard*.

3.3 Discussion

We conducted Experiment 2 to further explore prototypicality and taxonomical hierarchy in AH with a cross-modal prototype test, with the category name as the auditory input and the exemplar picture as the visual stimulus. After eliminating those objects that adult raters and children disagreed upon, we found that AH demonstrated the prototypicality effect (in the error rate data) as normal controls, although her performance was generally poorer than that of the normal controls across the three conditions, as demonstrated in her longer RTs and higher error rates. During the follow-up interview, we found that AH indeed lacked the stored knowledge about some of the superordinate categories, in line with what we had found in the follow-up interview of Experiment 1 with non-linguistic materials. However, we also found that her high error rate in Experiment 2 might not be entirely due to her lack of knowledge of taxonomical hierarchy and categorization, but partially due to the time pressure she had when performing the online cross-modal task. Finally, AH demonstrated some word naming problems and hierarchical processing difficulty from lower to higher categories during the interview, indicating that she might have problems retrieving the names/labels of the tested objects and establishing a lower-to-higher relationship between objects and their superordinate categories.

4. General summary and discussion

The purpose of the present study was to examine the intactness of a PWS patient's (AH) conceptual systems with linguistic and non-linguistic materials by looking into two important dimensions capturing the external and internal structure of semantic categorization—taxonomical hierarchy and prototypicality. From the online tasks, we found that although the taxonomical hierarchy of some categories was partially intact and that the prototypicality effect was also present to some degree, the patient's overall performance was much poorer than that of the normal controls in both Experiments 1 and 2. To have a complete picture of AH's organization of the taxonomical system and to better understand the nature of her problems, we conducted follow-up interviews. The interviews corroborated the findings in the online experiments that AH's taxonomical hierarchy was indeed incomplete and that she lacked the semantic representations for some of the exemplars under certain categories. However, the fact that AH sometimes gave correct responses in the interview to the questions that she answered wrong during the online prototype test revealed that AH's online performance was affected by the time pressure, suggesting that her prototypicality effect could have been stronger if more time had been permitted during the experiment (although we did give AH 11.5 more seconds than normal controls to respond).

The incompleteness of hierarchy in AH's conceptual structure may come from her non-linguistic deficits. Whitman and Thompson (2006) pointed out that PWS patients suffer from some deficits in higher-order cognitive processing, such as abstract thinking and metacognitive abilities ("thinking about thinking"). These abstract thinking difficulties and metacognitive malfunctioning characteristics result in academic and social functioning inabilities, which further hamper language, executive functions, memory, generalization ability, visuomotor skills and objective judgment in PWS individuals (also see Sullivan and Tager-Flusberg 2000; Tager-Flusberg and Sullivan 2000 for similar results). The deficits in abstract thinking indeed manifested itself in AH while she was performing the exclusion task in Experiment 1. She could name all the objects in a trial, for example, *zebra* (斑馬), *sheep* (綿羊), and *refrigerator* (冰箱), but she seemed unable to form an abstract/higher level to group *zebra* and *sheep* together while excluding *refrigerator*.

Also, it is interesting to note that AH seemed to show more problems in lower-to-higher than higher-to-lower hierarchical processing in the follow-up interview of Experiment 2: She could answer *dog/doggie* while being asked what ANIMAL was, but she hesitated when further asked "Is a dog an animal". Previous research has found that PWS patients have difficulty in linear/sequential processing (Curfs, Wiegers, Sommers, Borghgraef & Fryns 1991). Therefore, in addition to her weak abstract thinking, AH's being poorer at questions requiring processing from lower to higher levels in the conceptual structure might be due to her impaired linear/sequential processing. However, exactly why it is more difficult to process conceptual information from lower to higher levels but not the other way around needs further examination.

In addition to the abstract thinking and serial processing problems, the generalization problem found in previous PWS literature might also contribute to AH's incomplete hierarchy, as demonstrated in her performance in the practice trials of Experiment 1. One of the trials contained *toilet, pizza* and *bathtub*. *Pizza* should have been excluded, but somehow AH insisted that *toilet* be excluded. After careful instructions and explanations, she finally realized that *pizza* should have been excluded since it was an out-of-category object, not belonging to the superordinate category that *toilet* and *bathtub* were under. However, when another practice trial came, which contained *hamburger*, *cookies*, and *wig*, she chose *hamburger* and insisted that it was an out-of-category object. The same process of instructions and explanations had to be given over and over again. After the first round of all the practice trials, the same practice trials were used again to ensure that she had understood how to do the task. Compared to the normal children who got the exclusion idea after the demonstration of the first practice trial, AH had to be reinstructed or retaught and then the ideas would be reinforced or fortified in her.

Other than the deficits of abstract thinking, serial processing and generalization mentioned above, the fact that AH did not possess as many superordinate categories and exemplars as the normal children might have to do with her different life experience or educational background, deeply influenced by her syndrome-induced mental retardation. For example, familiarity/frequency might play vital roles in forming the taxonomical hierarchy. Further discussing with her family, we found that AH seldom read books or watched TV programs about creatures or living things, and that might be the reason why the exemplars under some superordinate category, like ANIMAL, were quite limited. She knew *spotted deer* (梅花鹿) simply because there were many such deer in Mazu. Preference may be another important factor for forming categories, such as FRUIT and CLOTHING. AH goes to the traditional market every morning to buy vegetables and fruits. She also likes to get herself beautifully dressed, and sometimes changes clothes several times a day. Her preference for the fruits/vegetables and clothing, which may in turn strengthen the frequency and familiarity of such categories, strongly evidences why she knows relatively more about the superordinate categories FRUIT and CLOTHING than the others. Future studies manipulating semantic features of categories and members may help elucidate the "familiarity effect" in this study.

In sum, AH's taxonomical hierarchy in the conceptual systems seems partially impaired/intact. Due to her mental retardation and learning experiences, it is evident that she has not acquired as many within-category exemplars as normal children. Deficits in abstraction, serial thinking and generalization may impede her categorization, and her life background, including familiarity/frequency and preference, may determine the size of her taxonomical structure (i.e. how many hierarchical levels can be differentiated and how many exemplars are there in a superordinate category).

After the discussion of the taxonomical hierarchy in AH, we now turn to the other factor that was examined in the study: prototypicality. Prototype effects have been reported as an important factor in representations of semantic categories and language acquisition (Rosch 1973, 1975, Rosch & Mervis 1975, Rosch, Mervis, Gray, Johnson & Boyes-Braem 1976). A manifestation of prototypicality effects was also substantiated in the present study: higher error rates and longer response times for the peripherals than the centrals among the controls and, importantly, also in AH: She made more errors for peripherals (91%) than for centrals (55%). Such effects also manifested themselves in the follow-up interview of Experiment 2. When the centrals objects under ANIMAL, such as *giraffe* (長頸鹿), *leopard* (豹), and *horse* (馬) were presented, AH recognized all of them, except for *leopard*, which she named “cat (貓)”. After naming these animals, she agreed that all of them were animals after the categorization question “_____ is an animal (_____ 是動物嗎)?” was delivered. However, when she was asked if *snail* (蝸牛) was an animal, she pondered a little while and answered with great hesitation. Promptness and procrastination (delay) of the responses to the centrals (*giraffe/leopard/horse*) and the peripheral (*snail*), respectively, reveal the effects of prototypicality.

Peripherals are positioned/scattered in the more outer/farther regions from the center of a concentric conceptual system, and the retrieval of these peripheral objects requires more cognitive efforts, which renders more time consumed. Besides, peripheral objects, by definition, are almost on the borderline between two superordinate categories; their demarcation of categorical status is not usually clear-out. For example, *hose* (水管) which had been rated by 47 out of the 50 adults as under the superordinate category of TOOL, was, by contrast, denied as a tool by half of the 26 normal controls. The mismatch between adults’ and children’s categorization found in Experiment 2 should be deemed to be one of the features of peripherals. AH’s prototypicality scope, despite her chronological age being over 20 years old, was as small as (sometimes even smaller than) those of the normal controls, whose chronological age was 9. She denied *backpack* (背包), *handbag* (手提包), *watch* (手錶), and *glove* (手套) as under the category CLOTHING, which was consistent with the normal children’s responses but against the adults’ ratings.

It is important to note that in Experiment 2, a mismatch between the controls’ erroneous responses for the peripherals and the adult raters’ ratings in the pilot test was observed (see Table 2). The disagreement upon the inclusiveness of an object within a category might come from the age-induced ideations. In other words, the normal controls and the adult raters are two groups of different ages; their ideas of prototypicality might differ in many ways, depending on how much knowledge they have acquired so far in life. *Record player* (唱片放奏機) is a typical case to explain the existence of a generational gap; many young children, quite familiar with MP3 players and smart phones now, do not even know what a record player is. For most of the adults, a *watch* not only provides a time-telling function but also serves as one of the accessories for their outfits, while for elementary school students, knowing the time seems not as important because what they have to do in school is follow the school bell system to have a class and take a break “on time”. *Sled* (雪橇) might not be as familiar as *car* to the raters and the controls as well in Taiwan. However, adult raters did not seem to have a problem recognizing *sled* as under the category of VEHICLE, since they had accumulated at least a certain level of encyclopedic knowledge than children. On the contrary, children denied that *sled* was a vehicle, simply because they had never seen any in Taiwan, which is one classic culture-biased example.

The mismatch between children's responses and adults' ratings is the by-product of prototypicality effects. Prototypicality scope varies in age: the more mature we become, the more encyclopedic knowledge we accumulate, and the larger prototypicality scope we hold. Schematically, a prototypicality scope is like a circle. Adults' prototypicality circle may be larger than that of children, and the mismatch is derived from the non-overlapping (residual) area when children's circular scope lies concentrically upon adults' scope. Future norming on prototypicality should be administered on an age-matched group to get more comparable results.

Finally, some other linguistic phenomena were also found in AH, such as overextension, underextension, use of circumlocution as she underwent word retrieval difficulties, etc. Since the current study focused on the "structure" of AH's conceptual systems, future study on the lexical semantics of her language might shed some light on the "content" of her conceptual systems.

5. Conclusion

Our findings add to the literature of language deficits in PWS patients. As addressed in the literature review, PWS individuals suffer from deficits in many aspects of language. Our study revealed that the taxonomical hierarchy in PWS patient (AH) was incomplete in some categories (Experiment 1) and that prototypicality was effective to some degree in her categorization (Experiment 2). Future research with different research tools, such as neuroimaging techniques, and with more patients, is needed to further explore the biological foundations of the current findings.

Appendix 1. Prototypicality Pilot Test

您好!我是＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿。 感謝您抽空填寫本問卷。本研究所蒐集的所有資料，僅供本人做學術上的研究，不會拿做其他用途，請您放心。

<u>基本資料</u>

性別: □女□男

年齡: ＿＿＿

系級: ＿＿＿系/＿＿＿年級

慣用手: □左手□右手
母語: □國語□台語□客語□其他（請說明__________）(可複選)
其他會講的語言: __________ =>流利程度□非常流利□尚可溝通□不太會
(學了多久____________)
__________ =>流利程度□非常流利□尚可溝通□不太會
(學了多久____________)

填答說明
每一大題有一個類別名稱（例如：早餐類）以及數個例子（例如：燒餅油條），請依直覺評判每個例子屬於該類別的程度 (在評斷時，沒有所謂的正確答案，請依您的實際狀況與感受作答)。

範例: 早餐類

像不像 / 例子	根本不是	非常不像				非常像
燒餅油條	0	1	2	3	4	5
鹹酥雞	0	1	2	3	4	5
字典	0	1	2	3	4	5

Appendix 2. Prototypicality Pilot Test*

1 動物類

像不像 / 例子	根本不是	非常不像				非常像
貓	0	1	2	3	4	5
短吻鱷	0	1	2	3	4	5
乳牛	0	1	2	3	4	5
鹿	0	1	2	3	4	5
大象	0	1	2	3	4	5
長頸鹿	0	1	2	3	4	5
大猩猩	0	1	2	3	4	5

袋鼠	0	1	2	3	4	5
獅子	0	1	2	3	4	5
豬	0	1	2	3	4	5
兔子	0	1	2	3	4	5
犀牛	0	1	2	3	4	5
綿羊	0	1	2	3	4	5
斑馬	0	1	2	3	4	5
松鼠	0	1	2	3	4	5
螃蟹	0	1	2	3	4	5

2 廚具(含餐具)類

像不像 / 例子	根本不是	非常不像				非常像
碗	0	1	2	3	4	5
刀子	0	1	2	3	4	5
掃把	0	1	2	3	4	5
杯子	0	1	2	3	4	5
流理臺	0	1	2	3	4	5

* This is merely a part of the entire questionnaire sheet.

References

Akefeldt, A., Åkefeldt, B., and C. Gillberg. 1997. Voice, speech and language characteristics of children with Prader-Willi syndrome. *Journal of Intellectual Disability Research* 41.4:302-311.

Barsalou, L.W. 1992. *Cognitive Psychology: An Overview for Cognitive Scientists.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Bellugi, U., Bihrle, A., Neville, H., Doherty, S., and T. L. Jernigan. 1992. Language, cognition, and brain organization in a neurodevelopmental disorder. *Developmental Behavioral Neuroscience: The Minnesota Symposia on Child Psychology*, eds. by M. Gunnar and C. Nelson, 177-189. Hillsdale, NJ: Erlbaum.

Branson, C. 1981. Speech and language characteristics of children with Prader-Willi syndrome. *The Prader-Willi Syndrome*, eds. by V.A. Holm, S. Sulzbacher, and P.L. Pipes, 179-183. Baltimore, MD: University Park Press.

Butler, M.G., Bittel, D.C., Kibiryeva, N., Talebizadeh, Z., and T. Thompson. 2004.

Behavioral differences among subjects with Prader-Willi syndrome and type I or type II deletion and maternal disomy. *Pediatrics* 113.3:565-573.

Carroll, D.W. 1999. *Psychology of Language*. Pacific Grove, California: Brooks/Cole Publications. Cassidy, S.B. 1984. Prader-Willi syndrome. *Current Problems of Pediatrics* 14:1-55.

Cassidy, S.B. 1997. Prader-Willi syndrome. *Journal of Medical Genetics* 39:917-923.

Cassidy, S.B., and D.J. Driscoll. 2009. Prader-Willi Syndrome. *European Journal of Human Genetics* 17:3-13.

Chapman, R. S. 1997. Language development in children and adolescents with Down syndrome. *Mental Retardation and Developmental Disabilities Research Reviews* 3.4:307-312.

Conners, F.A., Rosenquist, C.J., Atwell, J.A., and L.G. Klinger. 2000. Cognitive strengths and weaknesses associated with Prader-Willi Syndrome. *Education and Training in Mental Retardation and Developmental Disabilities* 35.4:441-448.

Cruse, D.A. 1986. *Lexical Semantics*. Cambridge: Cambridge University Press.

Cruse, D.A. 1990. Prototype theory and lexical semantics. *Meanings and Prototypes: Studies in Linguistic Categorization*, ed. by S.L. Tsohatzidis, 382-402. London: Routledge.

Cruse, D.A. 1994. Prototype theory and lexical relations. *Rivista di Linguistica* [*Journal of Linguistics*] 6.2:167-188.

Cruse, D.A. 2004. *Meaning in Language: An Introduction to Semantic and Pragmatics*. Oxford: Oxford University Press.

Curfs, L.M.G., and J.P. Fryns. 1992. Prader-Willi syndrome: A review with special attention to the cognitive and behavioral profile. *Psychosocial Aspects of Genetic Counseling*, eds. by G. Evers-Kiebooms, J.P. Fryns, J. Cassiman, and B.H. Vanden, 99-104. NY: Wiley-Liss.

Curfs, L.M.G., Wiegers, A.M., Sommers, J.R., Borghgraef, M., and J.P. Fryns. 1991. Strengths and weaknesses in the cognitive profile of youngsters with Prader-Willi syndrome. *Clinical Genetics* 40.6:430-434.

Defloor, T., Van Borsel, J., and L.M. Curfs. 2000. Speech fluency in Prader-Willi syndrome. *Journal of Fluency Disorders* 25:85-98.

Downey, D.A., and C.L. Knutson. 1995. Speech and language issues. *Management of Prader-Willi Syndrome*, eds. by L.R. Greenswag and R.C. Alexander, 142-155. 2nd ed. New York, NY: Springer-Verlag.

Dunn, H.G. 1968. The Prader-Labhart-Willi syndrome: review of the literature and report of nine cases. *Acta Paediatrica Scandinavica Supplement* 186:3-38.

Dykens, E.M. 2002. Are jigsaw puzzle skills ‘spared’ in persons with Prader-Willi syndrome? *Journal of Child Psychology and Psychiatry* 43.3:343-352.

Edmonston, N.K. 1982. Management of speech and language impairment in a case of Prader-Willi syndrome. *Language, Speech, and Hearing Services in Schools* 13:241-245.

Forster, K.I., and J.C. Forster. 2003. DMDX: A windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, and Computers* 35.1:116-124.

Gopnik, M., and M. B. Crago. 1991. Familial aggregation of a developmental language disorder. *Cognition* 39.1:1-50.

Hall, B.D., and D.W. Smith. 1972. Prader-Willi syndrome. *The Journal of Pediatrics* 81:286-293.

Holm, V.A. 1981. The diagnosis of Prader-Willi syndrome. *The Prader-Willi Syndrome*, eds. by V.A. Holm, S.J. Sulzbacher, and P.L. Pipes, 27-44. Baltimore: University Park Press.

Holm, V.A., Cassidy, S.B., Butler, M.G., Hanchett, J.M., Greenswag, L.R., Whitman, B.Y., and B.Y. Greenberg. 1993. Prader-Willi syndrome: consensus diagnostic criteria. *Pediatrics* 91:398-402.

Holm, V.A., Sulzbacher, S., and P.L. Pipes. 1981. *The Prader-Willi syndrome*. Baltimore, University Park Press.

Kleppe, S.A., Katayama, K.M., Shipley, K.G., and D.R. Foushee. 1990. The speech and language characteristics of children with Prader-Willi syndrome. *Journal of Speech and Hearing Disorders* 55:300-309.

Lewis, B.A. 2006. Speech and language disorders associated with Prader-Willi syndrome. *Management of Prader-Willi Syndrome*, eds. by M.G. Butler, P.D.K. Lee, and B.Y. Whitman, 272-283. 3rd ed. New York, NY: Prader-Willi Syndrome Association (USA).

Lewis, B.A., Freebairn, L.A., Heeger, S., and S.B. Cassidy. 2002. Speech and language skills of individuals with Prader-Willi syndrome. *American Journal of Speech and Language Pathology* 11:285-294.

Lewis, B.A., Freebairn, L.A., Sieg, F.L., and S.B. Cassidy. 2000. Narrative skills of individuals with Prader Willi syndrome. PWSA (USA) 15th Annual Scientific Conference. Pittsburgh, PA.

Munson-Davis, J.A. 1988. Speech and language development in Prader-Willi syndrome. *Management of Prader-Willi Syndrome*, eds. by L.R. Greenswag and R.C. Alexander, 124-133. New York, NY: Springer-Verlag.

Nazzi, T., Paterson, S., and A. Karmiloff-Smith. 2003. Early word segmentation by infants and toddlers with Williams syndrome. *Infancy* 4:251-271.

Neville, H., Mills, D., and U. Bellugi. 1994. Effects of altered auditory sensitivity and age of language acquisition on the development of language-relevant neural system: preliminary studies of Williams syndrome. *Atypical Cognitive Deficits in Developmental Disorders: Implications for Brain Function*, eds. by S. Broman and J. Grafman, 67-83. New Jersey: Lawrence Erlbaum Association.

Prader, A., Labhart, A., and H. Willi. 1956. Ein syndrom von adipositas, kleinwuchs, kryptorchismus und oligophrenie nach myatonieartigem zustand im neugeborenalter [A syndrome of obesity, short stature, cryptorchidism and oligophrenia after myatonieartigem state in neugeborenalter]. *Schweizerische Medizinische Wochenschrift* [*Swiss medical weekly*] 86:1260-1261.

Prader-Willi Syndrome Association. 1980a. *Speech Pathology*. Edina, MN: Author.

Prader-Willi Syndrome Association. 1980b. *Synopsis. Prader-Willi syndrome and association*. Edina, MN: Author.

Roberts, J. E., Price, J., and C. Malkin. 2007. Language and communication development in Down syndrome. *Mental Retardation and Developmental Disabilities Research Reviews* 12:26-35.

Rosch, E. 1973. On the internal structure of perceptual and semantic categories. *Cognitive development and the acquisition of language*, ed. by T.E. Moore. New York: Academic Press.

Rosch, E. 1975. Cognitive representations of semantic categories. *Journal of Experimental Psychology: General* 104:192-233.

Rosch, E., and C.B. Mervis. 1975. Family resemblance: Studies in the internal structure of categories. *Cognitive Psychology* 7:573-605.

Rosch, E., Mervis, C.B., Gray, W.D., Johnson, D.M., and P. Boyes-Braem. 1976. Basic objects in natural categories. *Cognitive Psychology* 8:382-439.

Snodgrass, J.G., and M. Vanderwart. 1980. A Standardized Set of 260 Pictures: Norms for Name Agreement, Image Agreement, Familiarity, and Visual Complexity. *Journal of Experimental Psychology: Human Learning and Memory* 6.2:174-215.

Stauder, J.E., Brinkman, M.J., and L.M.G. Curfs. 2002. Multi-modal P3 deflation of event-related brain activity in Prader-Willi syndrome. *Neuroscience Letters* 327.2:99-102.

Sullivan, K., and H. Tager-Flusberg. 2000. Higher-order mental state understanding in adolescents with Prader-Willi syndrome. *The Endocrinologist*, 10(4) Suppl1:38S-40S.

Tager-Flusberg, H.B. 1985a. Basic-level and superordinate level categorization by Autistic, mentally retarded, and normal children. *Journal of Experimental Child Psychology* 40:450-469.

Tager-Flusberg H., and K. Sullivan. 2000. A componential view of theory of mind: evidence from Williams syndrome. *Cognition* 76:59-89.

Taylor, R., and M.L. Caldwell. 1983. Psychometric performances of handicapped obese individuals with and without Prader-Willi syndrome. Paper presented at the Meeting of the American Association on Mental Deficiency, Dallas, TX.

Warren, J.L., and E. Hunt. 1981. Cognitive processing in children with Prader-Willi syndrome. *The Prader-Willi Syndrome*, eds. by V.A. Holm, S.J. Sulzbacher, and P.L. Pipes, 161-177. Baltimore: University Park Press.

Whitman, B.Y., and T. Thompson. 2006. Neurodevelopmental and neuropsychological aspects of Prader-Willi syndrome. *Management of Prader-Willi Syndrome*, eds. by M.G. Butler, P.D.K. Lee, and B.Y. Whitman, 245-271. 3rd ed. New York, NY: Prader-Willi Syndrome Association (USA).

Zellweger, H. 1979. The syndrome of Prader-Willi. Paper presented at the National Conference of the Prader-Willi Syndrome Association, Minneapolis.

Zellweger, H., Schneider, G., and H. Johannsson. 1968. Syndrome of hyptoniahypomentia-hypogonadism-obesity (HHHO) or Prader-Willi syndrome. *American Journal of Diseases of Children* 115:558-598.

[Received September 28, 2013; revised November 27, 2013; accepted November 28, 2013]

Department of English
National Taiwan Normal University
Taipei, TAIWAN
Li-chi Elvis Yang: elvisliqi@gmail.com
Shiao-hui Chan: shiaohui@ntnu.edu.tw

普拉德—威利症候群之語意分類：中文的個案研究

楊禮旗　　詹曉蕙
國立台灣師範大學

普拉德—威利症候群是一種與輕度和中度智能遲緩有關的先天性基因異常疾病。本研究以一名普拉德—威利症候群的病友(AH)為主要研究對象，旨在探查語意分類的兩個重要層面:語意類別外部的「階層結構」與語意類別內部的「原型效應」。透過兩組使用語言/非語言刺激的線上語意作業，我們發現與心理年齡相同的國小孩童相比，AH在整體的表現上落後許多。進一步的質性訪談證實AH的分類階層結構不完全，並且對於一些分類結構下的典範例子也缺乏固有的語意知識。然而，在AH較能掌握的語意類別裡，原型效應就略有示現。最後，本研究也在AH的言談中發現其的語言問題，再再驗證AH相較於正常孩童確實有概念知識上的缺損。

關鍵詞：普拉德—威利症候群、語意分類、分類階層結構、原型效應、中文