Appendix III
Related Literature

Appendix III.1
Description of AP Assessment Test

Researcher	Date	Subjects (Age)	Apparatus	N of Test Tones	Region	Duration of Tone	Intensity	Random Notes	Inter-stimulus Interval	Accuracy
Meyer	1899	Meyer (Adult)	Piano & tuning forks.	39	100Hz-4000Hz (δ G2-B7)	/	/	Yes	/	65%
		Heyfelder (Adult)								60%
Whipple	1903	Meyer (Adult)	Piano	75	Central	/	/	Yes	/	70%
				100	Middle					64%
				chords	Middle					92%
										85%
Boggs	1907	Gluck (Adult)	Piano	10-40 × 8	C1-B5	/	/	Yes	/	70% - 100% (M= 84.6%)
		Diseukes (Adult)		50	C4-B4					68%
		Solomon (14)		10 50	C2-B4 C4-B4					100%
		David(8)		50	C4-B4				One tone one day	50%
Mull	1925	Mu & P	Tonometer	12⊆2	/	/	/	Yes	/	/
Petran	1932	16AP (Adult)	Piano	50	C2-C6	1 second	Moderate	Yes, successive tones over an octave	/	/
Wedell	1934	/	Oscillator (in Sound proof room)	49	35Hz-50,000 Hz (δ G2-B7)	5 seconds	1000Hz at 40dB	Yes, no adjacent tones	10 seconds	/
Bachem	1937	103AP & 7 non-AP (Adult)	Piano, variator, violin, brass, tuning forks, singing, whistling, humming, bells, glass, automobile horns, spoon	88	All	2 seconds	/	Yes	/	1-2 semitones higher or lower as correct in shifting
Wedell	1941	9AP & 11 non-AP (Adult)	Piano	24	Whole piano range	/	/	Yes, Successive tones over an octave	/	0.5 semit-4 semit errors
Van Krevelen	1951	23AP (Adult)	Piano	88	Whole piano range	1 second	/	Yes, No consecutive tones	Long to write down answers	/
		17AP (17-37)	Oscillator	48	Middle 4	/				
Carpenter	1951	1AP (Adult)	Tuning fork oscillator	28⊆2 1⊆2	65Hz-1300Hz 608Hz	/	/	Yes	/	A mean Error of 2.5%
Hartman	1954	12 (Adult)	Oscillator	9⊆4	C3-B5	2 seconds	50dBSPL	Yes	6 second noise &1 second silence	None 100% accurate

Researcher	Date	Subjects (Age)	Apparatus	N of Test Tones	Region	Duration of Tone	Intensity	Random Notes	Inter-stimulus Interval	Accuracy
Cuddy	1968	28 music & 60 art students (Adult)	oscillators	12	C#2-C7	2 seconds	75±5dBSPL	Yes	10 seconds	Average error <1 semitone
			piano	12⊆2						
Sergeant	1969	Adult	Piano, oboe, Clarinet Violin glockenspiel monochord guitar, organ flute, cello	50	/	/	Yes	/	/	/
Brady	1970	Brady (Adult)	Piano	57	C#2-C7	2 seconds	comfortable	Yes	One day one note	65%
Heller & Auerbach	1972	8 students (Adult)	Oscillator	10	F4-D5	1 second	50dB	Yes	10 seconds	/
Siegel	1974	12 music students (Adult)	Pitch pipe	12	One octave	/	/	Yes	/	100%
Baggaley	1974	45 music students (Adult)	Piano	12	Db3-F5	Until tones fade away	/	Yes	/	/
Veron	1977	Veron (Adult)	Piano	64	A1-C7	/	/	Yes, no consecutive tones	15 seconds	87.5%
			organ							90.7% (2 semitones higher as correct)
Lockhead & Byrd	1981	4 AP & 4 non-AP students (Adult)	Grand., Piano	82 (400 trials, 16x25)	C1-A7	Until subjects wrote answers	/	Yes	1/4 seconds	99% (with feedback)
			oscillator		C2-A8		/	Yes	1/4 second	58%
Balzano	1984	Balzano & 2 music students (Adult)	Synthesized tones by computer	36	A2-Ab5	1 second	83dBSPL	Yes	2 seconds glissandos from 0 to 5500Hz	98.2% 84.3% 87.5%
Klein et al	1984	14 students (Adult)	oscillator	81	C2-C8	Until Subjects responded	/	Yes	500 mesc	100%
										60.63%
Profita & Bidder	1988	19AP (Adult)	Piano	/	/	/	/	Yes	/	90%
Zatorre & Beckett	1989	18AP (Adult)	Recorded grand piano tones	12⊆4 series	C2-G6	1/2 seconds	/	Yes, a fourth apart	6 seconds	84.7%
Miyazaki	1989	7AP & 18 non-AP music students (Adult)	Recorded grand piano tones	84	C1-B7	0.8 seconds	comfortable	Yes, Successive tones over an octave	5 seconds	91.6%
			Synthesized piano tones							80.4%
			Synthesizer	72	C2-B7					74.4%
Rush	1989	/	/	120	/	/	/	Yes	/	Very few 100%, others 30%, 60% or 80%
Miller & Clausen	1997	7AP (Adult)	Piano	24, > a minor third apart	C3-C5	1 second	comfortable	Yes	/	1. 86.5%
		8AP (Adult)	Keyboard synthesizer							80.56%
Miyazaki	1990	32AP students (Adult)	piano-tone generator	60	C2-B6	0.8 seconds	comfortable	Yes, adjacent tones an octave apart	5 seconds	70%-90%
Takeuchi & Hulse	1991	/	/	/	/	/	/	Yes	/	90% & <1 semitone error

Researcher	Date	Subjects (Age)	Apparatus	N of Test Tones	Region	Duration of Tone	Intensity	Random Notes	Inter-stimulus Interval	Accuracy
Wayman et al	1992	14AP musicians (18-20)	/	73	C1-C7	2 seconds	/	Yes	8 seconds	66.75% - 99.32%
Miyazaki	1992	11AP music students (Adult)	/	84	7 octaves	0.8 seconds	comfortable	Yes, <1 octave	5 seconds	90%-100%
Tervanoemi et al	1993	8AP (Adult)	digital keyboard	50	/	/	/	Yes	/	/
Miyazaki	1993	41AP (Adult)	Synthesized piano tones	60	/	0.8 seconds	Comfortable	Yes, <1 octave	5 seconds	15AP > 90%, 9AP 40-80%
Burns & Campbell	1994	5AP (Adult)	synthesizer (in Sound-a atnuated booth)	15 series	B3-C#5	/	70dBSPL	Yes	/	<80%
Crummer et al	1994	12AP (Adult)	/	73	C1-C7	2 seconds	/	Yes	8 seconds	85% - 89.5% (semitone error as half right)
Miyazaki	1995	7AP (Adult)	/	60	>5 octaves	0.8 seconds	comfortable	Yes	5 seconds	>90%
Hantz et al	1997	10AP 20RP (Adult)	Digital piano	12	F1-G5	2 seconds	/	Yes	6 seconds	62.5%-100%
Miller & Clausen	1997	11AP (children) 12AP (children)	Synthesized piano and pure tones	24 × 2	A3-B4	1 second	comfortable	Yes	/	/
Baharloo et al	1998	48AP & 12 non-AP musicians (adult)	Synthesized Pure and piano tones	40	C2-C#8	1 second	/	Yes, separated over 2 octaves & 1 semitone	3 seconds	34AP highly accurate
Zatorre et al	1998	20 musicians (Adult)	synthesized piano tones	100	F#3-C#5	500 mesc	75dBA	Yes	1800 mesc.	10AP<0.6 semitone error
Pantev et al	1998	9AP (Adult)	piano	35	C2-C7	/	/	Yes	/	9AP< 90%
Mottron et al	1999	QC, an music savant (adolescent)	Synthesized piano tones	$12_{\subseteq}4$	C2-C6	500mesc	/	Yes	2 seconds	86% in written & 100% in verbal
				$13_{\subseteq}4$	C3-C4					88%
Marvin & Brinkman	2000	20AP 18 non-AP (Adult)	Synthesized violin and piano tones	25	G3-G5	1 second	comfortable	Yes, no two same successive pitches	12 second distractor tone	89.5%
Keenan et al	2001	27AP musicians (Adult)	Pure tones from computer	$13_{\subseteq}4$	F#3-F#4	500 & 30 mesc decay rate	/	Yes, separated by a fourth	4 seconds	/
				$12_{\subseteq}4$	F2-G5					
Lenhoff etal	2001	5 Williams syndrome (Adult)	Piano	/	/	/	/	Yes	/	93.7%, -97% semitone error 3/4 mark.
University of California Genetics of AP study	2003		Piano & pure tones from computer	40 piano & pure tones	/	1 second	/	Yes	/	/

~The End~

Appendix III.2.
Persons of Exceptional Abilities with Absolute Pitch

2.1. AP Persons with Exceptional Ability

2.1.1. Pepito Anesla

Richet (1900, cited in Shuter-Dyson & Gabriel, 1981) reported Pepito Anesla who played tunes on the piano at the age of two and a half. By three years and seven months old, he could play 20 pieces from memory including the harmonies. By six years of age, he could sing any notes from memory and name any notes played to him.

2.1.2. Erwin Nyiregyhazy

Révész (1925, 1953) found that Erwin Nyiregyhazy could imitate singing before the age of one. While he was two years old, he could sing back tunes correctly. He composed little tunes at three and a half. By the age of four, he could play back anything he heard on the mouth organ and the piano. When he was six years old, he started formal musical tuition. At seven years of age, he developed AP. He could analyse complicated chords. He could play back correctly at the third attempted a 13-note tune. He could memorize melodies harmonized in a simple manner with ease. At nine years old, he could play back a five-bar melody at the second attempt. He had an international reputation in piano performance, composition, improvisation and memory.

2.1.3. A Gifted Youngster

Révész (1953) mentioned a gifted youngster who could compare music with accompaniment at five years old. He possessed AP to the piano, strings, woodwinds, bells and glasses. He could analyse complicated chords and transpose simple music into any keys. After reading a piece of music of six and half minutes for eight times, he could play it back on the piano. He did so after two years. He could even write it out without mistakes.

2.1.4. Louis Armstrong

Collier (1983) studied Louis Armstrong, a jazz trumpeter in New Orleans. He could play the trumpet well from memory without proper training. When he was young, he sang in a street choir, where he watched jazz performances frequently. He learnt to play the trumpet by trial and error. He had many chances to play the trumpet with experienced players.

2.1.5. Nicolas Slonimsky

Slonimsky (1988) related that he was a piano genius. His aunt discovered him having AP early in his life. He started to learn piano at six years of age and was taught by his maternal aunt. In the entrance examination of the St. Petersburg Consevatory, he could name two notes played simultaneously, and consonant and dissonant chords of three to five notes. He played three piano pieces by Schumann, Chopin and Rubinstein. He got the highest grade in the piano playing and musical talent from the examiner, Glazunov.

2.1.6. Zach Glodberger

Rutz (1996) reported a young men, called Zach Goldberger. His AP was discovered by his music teacher in his five years of age. He could play back immediately what his piano

teacher played him after hearing.

2.1.7. Tony Kaye

Krieger (1997) reported that Tony Kaye, a professional musician in San Francisco, could name notes at his age of three. He spent many hours in listening to his father playing classical music. He knew all the notes by ear. He possessed AP and had chromesthesia. He transcribed old recordings as a living.

2.1.8. Wolfang Amadeus Mozart

Willet (2001) recorded that Wolfang Amadeus Mozart, at the age of seven, could perceived that the violin was tuned "half a quarter of a tone" higher that of his father's friend. Hamer (2001) reported that Mozart as a child prodigy could "'instantly name all the notes played at a distance, whether singly or in chords as on the clavier or any other instruments. Audiences everywhere were astounded by his talent" (p.50). In 1976, when he was 12 years old, he wrote out the Gregorio Allegri's Miserere performed in the Sistine Chapel from memory after hearing it twice. He returned some days later to the performance to make some minor corrections only.

2.1.9. Roy Bogas

Hall (2002) reported Roy Bogas, a concert pianist of San Francisco Ballet and other orchestras. He had AP. He learnt piano at his young age. By age of five, he took advanced lessons in piano. Within a year, he could memorize a Mozart piano concerto and played it at Carnegie Hall.

2.2. Persons with Severe Learning Difficulties

2.2.1. XY

Minogue (1923) described a mentally impaired person called XY. He had an I.Q. of 46, but showed excellent pitch discrimination and tonal memory. He could play jazz or classical music by sight or ear. He could sight-read the Marche Grotesque by Sinoling and the accompaniment for singers. In addition, he had remarkable memory for time, places and events.

2.2.2. L.

As reported by Owens and Grimm (1941), L. was a 23-year-old woman with a mental age of two years and nine months. Her I.Q. was 20. She had limited speech. She could play on the piano any popular music heard on the radio. She could play the Lullaby by Brahms in any keys sung to her. She could copy with hands on the piano. She could not play the music if named only.

2.2.3. L.

L. was an eleven-year-old idiot-savant boy who was studied by Scheerer et al (1945). He had an I.Q. of 50 in the Standford Binet Intelligence Test. He had very low achievement in school. He was keen at calendar calculation, recalling numbers of seven digits forward and six backward, adding up 10 to 12 two-place numbers as one called them out. He could spell many words forward and backward orally or in writing. His extraordinary memory showed in music too. He showed interest and ability at his three years of age. He liked to play the piano for hours without being taught. He could read simple scores, but played

solely by hearing. He had AP. He could play difficult music, such as Dvorak's Largo after hearing. He loved Othello and could sing the whole Credo, including the accompaniment and Italian words, without understanding the meaning of words. He liked to listen to the music of Beethoven, Schubert, Tschaikovsky and operas of Verdi on records. He could recognize names of the music and could complete the melodies. At 12 years old, he could play back a piano piece unknown to him played by a musician only after one hearing. The melody was right and the accompaniment was adequate.

2.2.4. Harriet

Viscott (1970) reported a 40-year-old mild mentally impaired women, called Harriet. She had an I.Q. of 87. When she was a baby, she was placed in a crib in the music studio where her mother taught students singing. At the age of four, she learnt to play the piano. She could play on the piano the songs that her mother taught students to sing. She could play anything from memory after one hearing. Later, she also learned to play the violin, trumpet, clarinet and French horn. She had AP and could name all the notes of four-note chords and modulations. She could play "Happy Birthday to You" in Mozart's style. She could improvise the right-hand part in the style of one composer and play the left-hand part in another style. On the other hand, her memory was excellent. She could memorize pages of meaningless telephone numbers after her father had read them to her.

2.2.5. J. L.

Charness et al (1988) reported J. L., a 36 year-old severely mentally retarded man. He was suffered from a damaged left cerebral hemisphere, leading him to blindness and hemiplegia since birth. Although his family was musical, he received no formal music training. He had parrot speech and started to play the piano at three years old. He practised for many hours a day. He listened to records of all types of music and enjoyed playing music. At his age of six, he had severe epilepsy. Because spastic, he found himself a way to use one better hand to play music on keyboard instruments. He could play the piano, organ, melodica and harmonica. He could learn a new piece fast after one hearing. He could transpose and improvise music. He had AP.

2.3. Persons with Autism

2.3.1. S

Anastasi and Levee (1960) mentioned S who was an autistic person due to brain damage. He had an I.Q. of 73. He learnt the piano at the age of seven and achieved high piano standard. He played with famous musicians. He could play by ear. He possessed excellent sight-reading technique. He practised piano for six to nine hours a day. His mother declared that he had AP. He listened only to classical music. He had strength, concentration, interest and emotion in playing the piano. Moreover, he had very good rote memory. After reading an article of two and a half pages about George Washington once, he could recite the passage correctly word by word. He had excellent memory for the date, time and venue of events. He could recall the details of classical composers.

2.3.2. NP

Sloboda et al (1985) spotted an autistic person called NP, who had low mental achievement

in all areas except in the piano performance. Since his early age, he listened to music a lot on the radio. He got access to a piano after 17 years of age. He spent much time in practising the piano and he could play many pieces from memory by adulthood. He learnt to play by memory, and by trial and error. He played music with great concentration and effort. At 21 years old, he could learn a new sonata-length piece after three to four hearings on the piano. He could play the guitar and recorder. He enjoyed playing in public. He had developed a repertoire of popular music, hymns and classical music. He was judged that he possessed AP. After listening to Grieg's Lyric Pieces Opus 47 No.3 "Melodie" no more than seven times, he could play it by seven trails. The same piece of music was tried by a professional pianist. The performance was impossible except the melody was just recognizable. Even though after a day, he could play it back perfectly. However, he failed to play back the "Whole Tone Scale" from Bartok's *Mikrokosmos* Book V after five trails. The attempt from the professional pianist was far better than NP's.

2.3.3. Two Musical Savants

Hermelin et al (1987) reported two autistic musical savants of 18 and 19 years old respectively. They had excellent music memory. They could play back music after hearing on the piano. It was found that they were superior to normal children in the overall musical inventiveness, such as in continuing and composing tunes, improvising accompaniments, composing melodies and accompaniments, and improvising jazz music. Moreover, they showed a better sense of timing, balance and more complexity.

2.3.4. Two Savants

Rinland and Fein (1988) reported two savants as follows: a) He could play anything he heard once on the piano or any keyboard instruments. He had AP. b) She could sing any note named. She had a large classical repertoire. She composed at the piano and taught herself to play the guitar.

2.3.5. QC

Mottron et al (1999) examined QC, an autistic adolescent with an I.Q. of 71. She had interest in music when she was two years of age. After hearing a tune once, she could play it back on a toy piano. She sang before she could speak. AP was developed at her age of four before any music training. It was suggested that her AP was inherent. She had a piano at four years of age. She received piano tuition at five years old. She practised the piano for less than two hours a day. She listened to classical and popular music often. She could read music at the age of ten. She could play simple chords from tunes after less than three trials. At 14 years old, she sang in the school choir. At 18 years old, she could play moderately difficult classical music, such as Debussy's Arabesque by memory after practice. She was testified as an AP processor. Her AP did not hinder her from using RP in musical settings. She was exceptional in melody recognition and recall.

2.3.6. Dominic

Heaton et al (1999) reported a boy suffered from Asperger's syndrome, called Dominic. He had normal intelligence. He had no language delay. He had exceptional good musical cognition comparing to children of the same intelligence and age, and to those of autism.

He had very little formal musical training. However, he showed good musical discriminative ability, judged small intervals accurately and identified chord tones correctly. He could detect melodic change and missing tones in chords well. He was poor in identifying emotions in music with major or minor modes.

2.4. Persons with Visual Impairment

2.4.1. Blind Musical Savants

Rife and Snyder (1931) cited a case mentioned by Tredgold in his book *Mental Deficiency*. A "born imbecile blind" boy could memorize and sing w ords and music after hearing. He had AP. They related another case of Dr. Goddard that "a blind imbecile girl" could play back a difficult piano music after hearing it once. They mentioned another blind "idiot boy" of 19 years old who had AP. He could play any music on piano after hearing.

2.4.2. Judy

Burlingham (1976) described a blind, backward and withdrawn child born with multiple handicaps, called Judy. She had motor difficulties and low intelligence. She learnt the piano at her six years of age. She could identify any notes on the piano and any notes in chords. She could transpose single melodies into other keys. She could recognize many pieces of music through listening, and name music and composers. She could recognize instruments played in orchestras.

2.4.3. C. A.

Comer (1985) reported a severely mentally retarded blind man called C. A. He was extremely sensitive to sounds. He learnt to play the accordion by hearing. He practised for many hours a day. He had AP. He played in public concerts since 14 years old.

2.4.4. Three Blind Musical Savants

Hermelin et al (1987) reported three blind musical savants of 31, 36 and 58 years of age respectively. They had excellent musical memory. They could memorize many songs and piano music. They could play back tunes after few hearings. They were superior to normal children of similar mental age in the overall musical inventiveness, such as in continuing and composing tunes, improvising accompaniments, composing melodies and accompaniments, and improvising jazz music. Moreover, they showed a better sense of timing, better balance and more complexity in the above-mentioned activities.

2.4.5. A Blind Man

Hermelin, O'Connor, and Treffert (1989) examined a 34-year old blind man with an I.Q. of 40. He was suffered from cerebral palsy too. He started to learn piano under his adoptive mother at eight years old. At twelve years of age, he could play back Tchaikovsky's First Piano Concerto after hearing once on television the night before. He could play back music after one hearing nearly accurately. He could improvise music elaborately with rich melodic lines, tonality and texture. He could imitate the style and voice of some vocalists.

2.4.6. Thomas Wiggins

Miller (1989) described that Thomas Wiggins, also called the blind Tom, was the earliest known case of musical savant. He was a born slave on a Southern plantation in 1849. He was genitally blind. He was sensitive to natural sounds, and could imitate animal and bird

calls accurately. He could play back melodies on the pianos. He received music training early from his owner's wife. He had AP. He could play back music after one hearing. He could compare and improvise music. He gave concerts locally and throughout the South at eight and ten years old. He gave concert tours in the United States and Europe for the rest of his life. He had excellent memory and had repertoire of 3000 classical piano music.

~The End~